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Volume 26, Number 20, October 31, 1972

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NEWCOMB, William A., Stability of a magnetic well, 25:1239
NEWKIRK, L. R., Superconductivity in the pseudobinary
  alloys V_3Si--Nb_3Al, 25:1093 (CALT-822-13)
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  (AAEC/LIB/Bib-254)

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  determination in luminescent material by scintillation
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372 (UCRL-72739) CONSTRUCTION OF A UNIQUE UNDERGROUND WHOLE BODY COUNTER. Griffith, R. V.; Anderson, A. L.; Lindeken, C. L. **(California Univ., Livermore. Lawrence Radiation Lab.).** Oct 1970. 27p. (CONF-701009-1). Dep. NTIS.

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    25:372 (UCRL-72739)

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NUCLEAR SCIENCE ABSTRACTS

CHEMISTRY

Analytical Chemistry

Refer also to abstracts 48042, 48119, 48355, 48365, and 49316.

47653 (LAMS–2597) ANALYTICAL CHEMISTRY PROGRAM FOR THE ANALYSIS OF URANIUM-LOADED GRAPHITE FUEL ELEMENTS. Ashley, W. H.; Henicksman, A. L.; Metz, C. F.; Phelps, R. T. (Los Alamos Scientific Lab., N. Mex.). 1 Aug 1961. Contract W-7405-eng-36. 73p. Dep. NTIS.

Fabrication of fuel elements from UO_2 and graphite requires chemical analyses of raw materials and finished product. Methods, which are largely modifications of previously existing methods, are described in detail for UO_2, graphite, and Nb analysis for impurities, for determination of uranium, iron, and ash in graphite, and for determination of volume density of uranium-loaded graphite. (M.C.G.)

47654 (PAEC(A)–7116(Suppl.4)) NUCLEAR ENERGY IN THE PHILIPPINES. An Annotated Bibliography. (Philippine Atomic Energy Commission, Manila). Dec 1971. 31p. Dep. NTIS (U. S. Sales Only).

Seventy-seven references are included and arranged alphabetically by titles under their respective subject headings together with their bibliographic data. A brief annotation or a summary of the article is included. An author index is provided. Subject headings include: chemistry, geology and mineralogy, health physics, instrumentation, isotope technology, life sciences, physics, reactor technology, and general and miscellaneous. (M.C.G.)

Activation and Nuclear Reaction Procedures

Refer also to abstracts 47916 and 47919.

47655 (BNL–16919) RADIOISOTOPE DETERMINATION OF WHOLE-BODY MAGNESIUM BY IN VIVO NEUTRON ACTIVATION. Dombrowski, C. S.; Wallach, S.; Shukla, K. K.; Cohn, S. H. (Brookhaven National Lab., Upton, N. Y.). 1971. 17p. (CONF-710553–1). Dep. NTIS.

From first international symposium on magnesium deficit in human pathology; Vittel, France (9 May 1971).

The determination of whole-body magnesium in vivo by neutron activation is described. The thermal neutron flux distribution within the body must be uniform in order to achieve a uniform activation of each ^{26}Mg atom independent of its position within the body. The induced γ activity must be measured quantitatively and a suitable correction applied to the data for interfering reactions. (M.C.G.)

47656 (GULF-RT-A–10973) INSTRUCTION MANUAL FOR OIL SLICK IDENTIFICATION BY TRACE ELEMENT PATTERNS MEASURED WITH NEUTRON ACTIVATION ANALYSIS. Lukens, H. R. (Gulf Radiation Technology, San Diego, Calif.). 30 May 1972. Contract AT(04-3)-167. 74p. Dep. NTIS.

The methodology of oil slick identification by neutron activation analysis and trace element patterns is presented. The following steps are described: acquisition of oil-slick sample and oil samples from suspected sources of the slick; preparation of samples; irradiation of samples and comparator standards under identical conditions; measurement of irradiated samples and standards by γ spectrometry; reduction of γ spectrometry data to obtain identification of trace elements and their concentrations; objective comparison of trace element patterns of each suspect oil with the slick oil; and estimation of match between suspect and slick oils. (M.C.G.)

47657 (IRI–133-72-4) MERCURY DISTRIBUTION LEVELS OBSERVED IN VARIOUS ECOSYSTEMS AS DETERMINED BY NEUTRON ACTIVATION ANALYSIS. de Goey, J. J. M.; Houtman, J. P. W.; Tjioe, P. S.; Koeman, J. H. (Interuniversitair Reactor Instituut, Delft (Netherlands)). 1971. 27p. Dep. NTIS (U. S. Sales Only).

Since 1967 neutron activation analysis has been extensively applied in the Netherlands for investigating the distribution of mercury in water, plants, fish, birds, tissues of mammals, biological fluids, foodstuffs, industrial products, and pharmaceuticals. An automated instrument was devised for measurement of mercury concentrations above 0.1 ppB in 90 samples per week. Information is provided about the transport of mercury from soil (river sludge) via grass to cattle, about the behavior of mercury in the ecosystems water, molluscs, eiderduck; water, fish, sandwich tern; water, fish, seal, and about the uptake of mercury from organic seed dressings (through mice) by predatory birds. Mercury contents of various canned fish samples for human consumption are also given. (auth)

47658 FLUX MONITORING METHOD SUITABLE FOR RAPID ACTIVATION ANALYSIS WITH 14 MeV NEUTRONS. Tamura, Mituhisa (National Research Inst. for Pollution and Resources, Kawaguchi, Japan). Radioisotopes (Tokyo); 21: No. 7, 397-403(Jul 1972).

A new flux-monitoring method suitable for automatic activation analysis is described. The output of a detector of fast neutrons serves as a substitute for reference samples in comparator methods. Fast neutrons are detected by a plastic scintillator, the neutron intensities at each moment are stored in the memories of a multichannel pulse height analyzer, and then the integrated values of the products of the neutron intensities, the saturation factors, and the decay factors against various half-lives in question are calculated with a computer. The integrated values, namely activity equivalent values (ACTEQ), act as reference samples in comparator methods. In the experiments on the response of the ACTEQ program to various half-lives, it is shown that the ACTEQ method works very well even in an extreme fluctuation of the neutron source, and is suitable for quality control applications that require the rapid simultaneous analysis of multicomponent systems. An application of the ACTEQ method to the simultaneous determination of nitrogen and oxygen in an organic compound was carried out. The relative error was about 4% for nitrogen and about 2% for oxygen. It takes about 5 minutes for the determination. (auth)

47659 RADIOACTIVATION ANALYSIS WITH LOOPED SAMPLE IRRADIATION METHOD. OXYGEN DETERMINATION IN PETROLEUM SOLVENT BY 14 MeV NEUTRONS. Tsuji, Haruo; Fujiwara, Yoshinao; Okamoto, Masaaki; Nanba, Noriyasu; Kusaka, Yuzuru (Konan Univ., Kobe, Japan). Radioisotopes (Tokyo); 21: No. 7, 404-10(Jul 1972). (In Japanese).

Determination of oxygen in petroleum samples by 14-MeV neutron activation analysis with looped sample irradiation was studied. The sample fluid was recirculated between the activation and the counting zones. The selectivity and the sensitivity of the analysis can be enhanced by suitable selections of irradiation, decay, and counting times. Definite amounts of methyl isobutyl ketone in kerosine solution were used as standard samples and acetone in kerosine solutions as an analytical sample. Each liter of these samples was poured in the sample reservoir and was recirculated with the flow rate of 23 ml per sec. Irradiation with 14-MeV neutrons and measurement of the gamma spectrum were carried out simultaneously for 5 min. Relative neutron intensities during the experimental period were monitored with a neutron scintillator. From the gamma spectrum obtained, the 6.13-, 5.62-, and 5.11-MeV triplet photopeak intensity of ^{16}N produced by the ^{16}O(n,p) reaction was measured and normalized with the integrated counts of the neutron monitor to the one that corresponds to the standard neutron counts (8×10^5 counts per 5 min). In the gamma spectra of the standard and the analytical samples were the remarkable ^{16}N peaks observed, but in the kerosine blank sample it could not be detected. The calibration curve of oxygen analysis was a straight line in the concentration range investigated up to 5.0% oxygen. The analytical result for the sample of 1.12% oxygen, for example, was 1.08% and the standard deviation was 0.03%. The detection limit of this method, assuming it as the ^{16}N photopeak intensity equal to 10% of the background counts, was 0.2% oxygen at the neutron flux of 0.8×10^7n per cm^2 per sec. A smaller amount of oxygen could be determined by increasing the neutron flux and the detector shielding. (auth)

47660 DETERMINATION OF SOME TRANSITION ELEMENTS IN SOIL BY NEUTRON ACTIVATION ANALYSIS. Ohno, Shigeru (National Inst. of Radiological Sciences, Chiba, Japan); Hiki, Miyoko; Yatazawa, Michihiko. Radioisotopes (Tokyo); 21: No. 7, 411-14(Jul 1972).

The seven transition elements, scandium, chromium, manganese, cobalt, nickel, copper, and zinc, were determined in some soil samples using neutron activation analysis combined with solvent extraction methods. The radiochemical procedure for systematic separation of these seven trace elements from the irradiated sample is described. The recovery of the method is about 87% for scandium, 81% for chromium, 94% for manganese, 83% for cobalt, 94% for nickel, 87% for copper and 85% for zinc, and the limit of detection calculated from the analysis of standard specimen is about 0.02 ppM for scandium, 0.2 ppM for chromium, 0.001 ppM for manganese, 0.05 ppM for cobalt, 0.1 ppM for nickel, 0.01 ppM for copper, and 0.1 ppM for zinc. (auth)

47661 ACTIVATION ANALYSIS OF OSMIUM IN NATURAL MATERIALS AND INDUSTRIAL PRODUCTS. Rakovskii, E. E.; Khvostova, V. P.; Nikitin, V. N. (Central Research Mining and Prospecting Inst., Moscow). J. Radioanal. Chem.; 11: No. 1, 9-22(Jun 1972).

A survey of methods for radioactivation determinations of osmium in materials of various compositions is given, and the investigations on the development of a fast and highly sensitive method for determination of osmium in natural materials and industrial products are presented. (20 references) (auth)

47662 SELECTIVE ABSORPTION OF BROMINE ON COLUMNS OF SILVER NITRATE-LOADED POROUS GLASS POWDER AND ITS APPLICATION IN THE NEUTRON ACTIVATION ANALYSIS OF HIGH-PURITY SELENIUM. Soyka, W.; Havezov, I.; Erdtmann, G. (Kernforschungsanlage GmbH, Juelich, Ger.). J. Radioanal. Chem.; 11: No. 1, 23-33(Jun 1972).

A very simple method for determination of bromine in selenium was developed. The manual handling of the irradiated selenium sample is reduced to a minimum. After placing the sample in the dissolution flask, no further manipulation is necessary except for transference of the ^{82}Br counting sample from the dissolution apparatus to the scintillation counter. ^{82}Br is very selectively absorbed on columns prepared from surface-rich porous glass powder coated with silver nitrate. More than 95% of the bromine is absorbed on the columns and the decontamination factor for ^{75}Se is better than 10^{-7}. Commercially available selenium brands with bromine contents down to 0.025 ppM were analyzed. (auth)

47663 LIQUID-LIQUID EXTRACTION BEHAVIOR OF MERCURY(II) AS BROMIDE, IODIDE, AND THIOCYANATE. SEPARATION FROM Zn(II), Cd(II), Tl(I), Tl(III) AND Au(III). Gupta, C. B.; Tandon, S. N. (Univ. of Roorkee, India). J. Radioanal. Chem.; 11: No. 1, 59-66(Jun 1972).

The liquid-liquid extraction behavior of mercury(II) as bromide, iodide, and thiocyanate was investigated in different oxygenated and non-oxygenated solvents for use in neutron activation determination of Hg. The effects of the molarity of acids, their sodium or potassium salts, the concentration of Hg(II) ions, the temperature, and masking anions were studied. The possibilities of separation of Hg(II) from Zn(II), Cd(II) Tl(I), Tl(II), and Au(III) in these extractions are discussed. (auth)

47664 NEUTRON ACTIVATION ANALYSIS PROCEDURE FOR THE DETERMINATION OF URANIUM, THORIUM, AND POTASSIUM IN GEOLOGIC SAMPLES. Aruscavage, P. J.; Millard, H. T. Jr. (Dept. of the Interior, Denver). J. Radioanal. Chem.; 11: No. 1, 67-84(Jun 1972).

A neutron activation procedure was developed for determination of uranium, thorium, and potassium in basic and ultrabasic rocks. The three elements are determined in the same 0.5-g sample following a 30-min irradiation in a thermal neutron flux of $2 \cdot 10^{12}$ n · cm^{-2} · sec^{-1}. Following radiochemical separation, the nuclides ^{239}U (T = 23.5 m), ^{233}Th (T = 22.2 m), and ^{42}K (T = 12.36 h) are measured by β counting. A computer program is used to resolve the decay curves, which are complex owing to contamination and the growth of daughter activities. The method was used to determine uranium, thorium, and potassium in the U. S. Geological Survey standard rocks DTS-1, PCC-1, and BCR-1. For 0.5-g samples the limits of detection for uranium, thorium, and potassium are 0.7, 1.0, and 10 ppB, respectively. (auth)

47665 COMPARISON OF SINGLE- AND DUAL-AXIS ROTATION TECHNIQUES FOR TOTAL NITROGEN IN EXPLOSIVES BY FAST NEUTRON ACTIVATION ANALYSIS. Semel, S.; Helf, S. (Picatinny Arsenal, Dover, N. J.). J. Radioanal. Chem.; 11: No. 1, 91-7(Jun 1972).

Total nitrogen content in organic explosives and related materials can be determined by fast neutron activation analysis (FNAA) to an absolute accuracy comparable to wet chemical or combustion analysis, i.e. to within less than 0.1% N. This is accomplished by dual-axis rotation of the sample and a carefully selected reference standard during neutron irradiation. The optimum reference standard is one of similar composition, density, weight, and volume to the sample being analyzed. Rapid pneumatic transfer of organic explosives of low mechanical shock sensitivity poses no special safety problems. For large numbers of individual samples, a multiple sample irradiation system with single-axis rotation can be used for more rapid analysis. Precision and accuracy by this method are not as good as compared to a dual-axis rotation technique. Absolute accuracy for total nitrogen is in the order of 0.2%. This method is useful only for those reactions where the half-life of the product is long enough to allow for sequential counting of multiple samples for a single irradiation. (auth)

47666 DETERMINATION OF THE IRON CONTENT OF ALUMINATE LIQUORS FROM THE BAYER ALUMINA PROCESS BY NEUTRON ACTIVATION ANALYSIS. Bujdoso, E.; Miskei, M. (Research Inst. for Non-Ferrous Metals, Budapest). J. Radioanal. Chem.; 11: No. 1, 99-104(Jun 1972).

The behavior of iron in the Bayer process was investigated by neutron activation analysis and Ge(Li) spectrometry, using bauxite samples of various origin. The amount of iron impurities in alumina was found to be independent of the origin of the bauxites. Alumina is contaminated by iron in the process of decomposition of aluminate liquors; regardless whether iron is present in "dissolved" form or as a floating impurity, it will pass into the alumina almost completely. (auth)

47667 PROMPT PROTON SPECTROMETRY FROM HIGH Q-VALUE (d,p) REACTIONS AND ITS USE FOR DETERMINING ^{10}B. Olivier, C. (Univ. of Stellenbosch, South Africa); Peisach, M. J. Radioanal. Chem.; 11: No. 1, 105-22(Jun 1972).

The determination of boron in ore and glass samples was attempted by prompt proton spectrometry. A deuteron bombarding energy of 2.7-MeV was chosen to coincide with a region where the excitation function of the ^{10}B(d,p)^{11}B reaction did not vary apppreciably with energy. The intensity of the ground-state protons, emerging at an angle of 30°, was used as a measure of the boron content. Targets were prepared by a technique whereby approximately 300 μg/cm^2 deposits of powdered samples were centrifuged from a methanol suspension onto tantalum discs. Concentrations down to 0.2% were determined. Possible interference by other elements, particularly nitrogen, magnesium, and titanium, was investigated but found to be of little consequence mainly because of the high Q-value of the ^{10}B(d,p)^{11}B reaction. (auth)

47668 INSTRUMENTAL NEUTRON ACTIVATION ANALYSIS OF GUNPOWDER RESIDUES. Albu-Yaron, A.; Amiel, S. (Soreq Nuclear Research Centre, Yavne, Israel). J. Radioanal. Chem.; 11: No. 1, 123-32(Jun 1972).

A procedure was developed for the detection of gunpowder residues deposited on the hand of a person firing a gun. The method is based on neutron activation analysis of the antimony level on the surface of the hand. The surface materials are removed by a film made by spraying a 4% solution of cellulose acetate in acetone, which sets to form a thin film that can readily be stripped off. This technique was found to be preferable to the paraffin-lift technique which is in common use. Following neutron activation of the film in a nuclear reactor, antimony is assayed by high-resolution Ge(Li) spectrometry without prior chemical processing. The sensitivity of the method is about $5 \cdot 10^{-9}$ g Sb, with a precision of about ±10% at a neutron flux of $5 \cdot 10^{13}$ n · cm^{-2} · sec^{-1}. Analysis of twenty samples taken from the hands of persons who had fired a pistol gave Sb levels of 0.4 ± 0.2 μg, compared with 0.024 ± 0.013 μg found on the hands of persons who had not fired a revolver. The possible extension of the present technique to include the determination of additional elements is discussed. (auth)

47669 ACTIVATION ANALYSIS OF ARSENIC, COPPER, AND ANTIMONY IN SEA WATER. Gohda, Shiro (Kinki Univ., Osaka). Bull. Chem. Soc. Jap.; 45: No. 6, 1704-8(Jun 1972).

Arsenic, copper, and antimony in seawater were determined by thermal neutron activation analysis. Convenient pre- and post-irradiation procedures were proposed and some samples were analyzed. Arsenic, copper, and antimony were collected by the cocrystallization with thionalide, and were irradiated for 30 min in a neutron flux of 2×10^3 n/cm^2/sec. After the thionalide complex was decomposed with nitric acid, the copper and antimony were separated from the arsenic by precipitating with oxine, and the arsenic in the filtrate was coprecipitated with ferric hydroxide. Gamma spectra were obtained and the decays of the 0.44 to 0.67-MeV photo peak of ^{64}Cu plus ^{122}Sb and the 0.55-MeV peak of ^{76}As were followed. The arsenic, copper, and antimony contents in seawater were estimated to be 1.12 to 1.71 μg As/l, 1.49 to 3.35 μg Cu/l, and 0.22 to 0.57 μg Sb/l. (auth)

47670 CONTINUOUS NEUTRON ACTIVATION ANALYSIS OF FLOWING SOLUTIONS. III. INVESTIGATION OF OPTIMUM ANALYZING CONDITIONS. Kliment, V.; Toelgyessy, J. (Technical Univ., Bratislava). Isotopenpraxis; 8: No. 4, 143-5(Apr 1972). (In German).

Optimum conditions for carrying out continuous activation analysis were investigated on a laboratory scale. Subject of the investigation was the effect of the volume and form of the activation chamber on the value of induced activity of the solution. The dependency of the induced activity on the volume of the detection chamber, the position of the neutron source, and the position of the gamma detector was determined. The effect of test solution flowrate on the value of induced activity is indicated. (auth)

47671 NON-DESTRUCTIVE DETERMINATION OF MICROQUANTITIES OF IRIDIUM IN SOIL SAMPLES THROUGH ACTIVATION ANALYSIS. Stefanov, G.; Daieva, L. (Geological Inst., Sofia). Isotopenpraxis; 8: No. 4, 146-8(Apr 1972). (In German).

A nondestructive method of iridium determination in soil samples through activation analysis was developed. Test and reference samples were exposed to 5×10^{12} n cm^{-2} s^{-1} flux for 30 hours. This comparatively short exposure time was needed to eliminate the activity of other trace impurities ($T_{½}$ of ^{192}Ir = 74 days). After two or three weeks of cooling-down, ^{192}Ir was identified by means of the 317-keV peak. Quantitative evaluation of the results was carried out using the Covell method. The detection limit is 3×10^{-8} g of iridium. The standard deviation amounts to about 7.2%. (auth)

47672 NON-DESTRUCTIVE ANALYSIS OF MEDIEVAL GOLD COINS. Kowalski, H. (Commission of the European Communities, Brussels); Reimers, P. Kerntechnik; 14: No. 6, 265-8 (Jun 1972). (In German and English).

An absolutely nondestructive and relatively rapid analysis method for coins consisting of gold, silver, and copper, based on activation determination of the Ag/Cu ratio and gravimetric determination of the density is described. From these two values it is possible to calculate the composition of the ternary alloy and thus, for example, to determine the intrinsic value of the coins, whether and to what extent they deviate from the mint ordinances, if available, and whether they are genuine or counterfeit. (auth)

47673 DETERMINATION OF PICOGRAM AMOUNTS OF ^{99}Tc BY NEUTRON ACTIVATION ANALYSIS. Foti, S.; Delucchi, E.; Akamian, V. (Naval Ordnance Lab., White Oak, Md.). Anal. Chim. Acta; 60: No. 2, 261-8(Jul 1972).

A post-irradiation procedure for the determination of picogram amounts of ^{99}Tc in triply distilled water is described. The ^{99}Tc is irradiated in a thermal neutron flux of about $5 \cdot 10^{13}$ n cm^{-2} sec^{-1} to produce 16-sec ^{100}Tc. The chemical purification of the ^{100}Tc from other radionuclides requires 40 to 45 sec and the technetium yield is about 53%. The purified ^{100}Tc is counted in a low-background β-counter. (auth)

47674 DETERMINATION OF PICOGRAM AMOUNTS OF TECHNETIUM IN ENVIRONMENTAL SAMPLES BY NEUTRON ACTIVATION ANALYSIS. Foti, S.; Delucchi, E.; Akamian, V. (Naval Ordnance Lab., White Oak, Md.). Anal. Chim. Acta; 60: No. 2, 269-76(Jul 1972).

A procedure for the determination of trace amounts of ^{99}Tc in filter paper and vegetation samples by neutron activation analysis was developed. The procedure consists of the following major steps: pre-irradiation separation of technetium from the sample and purification of the technetium fraction; thermal neutron irradiation of the ^{99}Tc fraction to produce ^{100}Tc; post-irradiation separation and purification of ^{100}Tc from other activated nuclides; and counting of the 16-sec ^{100}Tc in a low-background β-counter. The estimated detection limits for ^{99}Tc by this procedure with irradiations at a thermal neutron flux of about $5 \cdot 10^{13}$ n cm^{-2} sec^{-1} are: $5 \cdot 10^{-12}$ g ^{99}Tc in filter paper samples and $9 \cdot 10^{-12}$ g ^{99}Tc in vegetation samples. (auth)

47675 POSSIBILITY FOR THE NONDESTRUCTIVE ANALYSIS OF PLANT SAMPLES THROUGH THE FAST NEUTRON ACTIVATION METHOD. Bornemisza-Pauspertl, Panna. ATOMKI (At. Kut. Intez.) Kozlem.; 13: No. 4, 173-80(1971). (In Hungarian).

Calculations were performed for intensity ratios of plant samples of average composition activated by 14-MeV neutrons. The spectra of natural plant samples taken with NaI(Tl) crystal and Ge(Li) semiconductor detectors supported the calculations. Under such conditions, from the measurements, the Mg content of the samples can be determined. There are also possibilities for certain comparative measurements. However, microelement determination without chemical separation is not made possible by the method. (auth)

47676 POSSIBILITY FOR THE DETERMINATION OF ^{235}U/^{238}U RATIOS BY THE ^{238}U(n,2n) REACTION. Raics, Peter. ATOMKI (At. Kut. Intez.) Kozlem.; 13: No. 4, 165-71(1971). (In Hungarian).

The ^{238}U(n,2n) reaction at 14 MeV gives a possibility for nondestructive determination of the enrichment ratio in uranium fuel elements, with Ge(Li) gamma spectrometry. The relative intensity of the 208.0 and 205.1 keV gamma lines of ^{237}U and ^{235}U, respectively, can be used to determine the ^{235}U/^{238}U ratio. Changes in gamma absorption, self-absorption and detector efficiency at the above energies do not affect the fast neutron activation differential analysis proposed. The method can be used with a few per cent accuracy for various practical configurations of uranium fuel elements, except Zr-alloyed or coated ones. (auth)

47677 INVESTIGATIONS OF THE RELATIVE TRANSFERENCE OF TRACE ELEMENTS FROM TOBACCO SMOKE CONDENSATE INTO MICE TISSUES. Nadkarni, R. A.; Ehmann, W. D. (Univ. of Kentucky, Lexington). Radiochem. Radioanal. Lett.; 11: No. 1, 45-57(31 Jul 1972).

Twelve trace elements were determined by thermal neutron activation and high resolution γ spectrometry in tissues from mice treated with tobacco smoke condensate. The elements determined were La, As, Br, Cr, Se, Ag, Cs, Sc, Zn, Fe, Co, and Sb. These elements were also determined in Kentucky 1R1 reference cigarette tobacco and the smoke condensate collected from it. The mice were skin-treated with this smoke condensate and the levels of trace elements were determined over a period of three months. Only minor differences in levels of certain trace elements in control and condensate-treated mice were found during this time period. The data on control animals, food and bedding are of value in the design of experiments for trace element toxicity in laboratory animals. (auth)

47678 SOME DATA ON THE MARINE GEOCHEMISTRY OF RHENIUM. Olafsson, J.; Riley, J. P. (Univ. of Liverpool). Chem. Geol.; 9: No. 3, 227-30(May 1972).

Neutron activation procedures were used for the determination of rhenium in seawater and sediments. Water from the North Atlantic was found to contain 2.7 to 5.8 ng l^{-1} of Re (average 4.0 ng l^{-1} Re). Analyses carried out on 11 samples of deep sea sediments, representative of the principal classes, showed highly significant correlations between Re and Si and between Re and the inverse of the carbonate content. No significant correlation was found between Re and Mn. It is suggested that the Re present in the sediments is associated with the silicate phases and this hypothesis is supported by adsorption studies. (auth)

47679 DETERMINATION OF MICROQUANTITIES OF ELEMENTS IN ROCKS AND ORES BY INSTRUMENTAL ACTIVATION METHODS AND SUMMATION SPECTROMETERS. Miranskii, I. A.; Ramazanov, R. Sh. At. Energ. (USSR); 33: No. 2, 706-7(Aug 1972). (In Russian).

The method of elemental microdetermination of Co, Sc, and Sb described used a system of two counters with NaI(Tl) crystals, a photomultiplier, a discriminator, and multichannel analyzer. Samples of rock and ore, together with Co, Sc, and Sb standards were irradiated in a neutron flux of 1.8×10^{18} n/cm^2 · sec for 20 hr, cooled for 20 days, and counted. The threshold sensitivity of Co is 10^{-5}% and Sc is 10^{-6}%. Techniques for identifying certain isotopes are discussed. (K.S.W.)

47680 IN-VIVO NEUTRON ACTIVATION ANALYSIS AND ASSOCIATED DOSIMETRY. Agard, Eugene Theodore. Toronto; Univ. of Toronto (1971). National Library of Canada, Ottawa.
Thesis.

The use of neutron activation analysis in-vivo for the measurement of calcium in the human body proved to be more accurate and less hazardous technique than many other methods currently used. The health hazard associated with this technique was determined by a method of neutron dosimetry based on the radiation damage in plastics caused by neutron-induced fission fragments. The lower legs of a phantom were irradiated for 10 minutes with four ^{238}Pu-Be neutron sources immersed in water. The 3.1-MeV ^{49}Ca gamma rays from the legs were counted by two NaI(Tl) scintillation detectors. The activity was such that there was a statistical error of 2%. The reproducibility of the results was determined from a series of 10 irradiations and the standard deviation was found to be ±2.3%. The expected interference from the 3.1-MeV peak in ^{37}S produced by the ^{37}Cl(n,p)^{37}S reaction was estimated to be about 2% and an experimental assessment of this interference showed that the contribution made by ^{37}S to the ^{49}Ca peak was about 4%. For neutron dosimetry, the plastic damaged by the fission fragments was etched in a 6N solution of NaOH, and the resulting holes counted by an electric sparking method. Experiments were carried out to find optimum processing procedures and to check the range of linearity of the system. ^{232}Th foils were adequate for determining the significant neutron dose, which was about 0.8 rem during irradiation of the legs. If required, ^{235}U foils may also be used to monitor thermal fluences. A comparison of fast neutron doses measured by this technique with a completely independent method at Brookhaven National Laboratories showed very good agreement. (Diss. Abstr. Int., B)

Chemical and Spectral Procedures

Refer also to abstract 48088.

47681 (BARC-583) SPECTROGRAPHIC ESTIMATION OF IMPURITIES IN SELENIUM AFTER REMOVING SELENIUM BY VOLATILIZATION. Joshi, B. D.; Bangia, T. R.; Dalvi, A. G. I. (Bhabha Atomic Research Centre, Bombay (India)). 1972. 29p. Dep. NTIS (U. S. Sales Only).

An emission spectrographic method for the estimation of the impurities Al, As, Ba, Bi, Ca, Cd, Co, Cr, Cu, Fe, Hg, Mg, Mn, Mo, Ni, Pb, Sb, Sn, Te, Ti, V, Zn, and Zr in high-purity selenium at concentrations less than one ppM has been developed. The impurities were separated from 1 g of selenium by volatilizing selenium from its solution in nitric acid and sulfuric acid. The residue containing impurities was dissolved in small amounts of 6M HCl and loaded along with its washing on 10 mg of graphite (90%) and sodium chloride (10%) mixture contained in the electrode crater. The spectra were excited in a dc arc carrying 13 A current. Palladium was used as an internal standard and sodium chloride as a carrier. The detection limits were in the range 0.005 to 0.5 ppM for the different elements. The precision of the method ranged from 7 to 18% for these elements. (auth)

47682 (BARC-590) ESTIMATION OF TRACES OF GASES IN METALS AND ALLOYS BY VACUUM FUSION TECHNIQUE. Venkatwswarlu, Ch. (Bhabha Atomic Research Centre, Bombay (India)). 1972. 28p. Dep. NTIS (U. S. Sales Only).

Hydrogen, oxygen, and nitrogen are common impurities in virtually all metals and alloys. The physical, mechanical, and electrical properties of the host metal are often influenced to a significant extent by these interstitial impurities. Of the various methods reported in literature, the vaccum fusion technique seems to be the most popular in the field for determination of gases in metals. The principle, apparatus, vocabulary, reaction media, general procedure, precision and accuracy, recent trends, and future scope for development in the vacuum fusion technique are reviewed. (70 references). (auth)

47683 (IAEA-R-984-F) DEVELOPMENT OF A METHOD FOR CONTINUOUS MEASUREMENT OF URANIUM INVENTORY OF PROCESS VESSELS. Final Report, February 1, 1971-January 31, 1972. Moeken, H. H. Ph. (International Atomic Energy Agency, Vienna (Austria)). Dec 1971. 11p. INIS.

The program of work was: installation of a conductivity meter on a process vessel (the density and liquid height measurement system was available); installation of an analog multiplexer and ADC (a small digital computer was available); interpretation of density and conductivity in terms of uranyl nitrate and nitric acid concentrations; and demonstration of the continuous measurement of uranium on a process vessel during the 1971 reprocessing campaign for highly enriched uranium. The experimentally derived equations relating density and conductivity to the two concentrations in the range 200 to 400 U/l and 0.5 to 1.5N acid are described. Combination of the two equations gives the g relationships between a concentration and the density and the conductivity, both measured at 20°C. Also the temperature coefficient of the conductivity in the concentration range considered is given to correct the conductivity value measured at other temperatures. (INIS)

47684 (NAA-SR-Memo-12149) MASS SPECTROMETRIC ANALYSIS OF MATERIALS. Young, W. A. (Atomics International, Canoga Park, Calif.). 9 Sept 1966. Contract AT-11-1-GEN-8. 9p. Dep. NTIS.
Declassified 22 Oct 1971.

A method is presented for determining the concentrations of the three isotopes of hydrogen and of helium-3 in mixtures of gases by mass spectrometry. The method presupposes that the gas mixture contains no helium-4 and that components of mass greater than 6 produce no appreciable concentrations of ions of mass 6 or less. The mixture must be in thermal equilibrium. The method is amenable to treatment by computer techniques. (auth)

47685 (NIM-1428) SEPARATION AND DETERMINATION OF TRACE AND MINOR AMOUNTS OF INDIVIDUAL RARE EARTHS IN SILICATES. Jones, Elaine A.; Watson, A. E.; Dixon, K. (National Inst. for Metallurgy, Johannesburg (South Africa)). 22 May 1972. 17p. Dep. NTIS (U. S. Sales Only).

After the sample is fused with potassium bifluoride, it is leached in dilute hydrofluoric acid, and the insoluble calcium and rare earth fluorides are filtered off. The paper is destroyed, the rare earths are converted to their chlorides, and the solution is passed through AG 50W-X8 cation resin (200 to 400 mesh) in 0.5 M hydrochloric acid. The rare earths and base metals are absorbed. The base metals are then eluted with 1.85 N hydrochloric acid, followed by elution of the rare earths with 4 N hydrochloric acid. The eluate containing the rare earths is converted to the sulfate form by evaporation to fumes of sulfur trioxide and is then passed through AG 1-X8 anion resin (200 to 400 mesh). The rare earths pass through the column, and scandium is absorbed. The eluate contains the rare earths, which are then precipitated using 8-hydroxyquinoline (with alumina as a carrier) and ignited to the oxides for spectrographic analysis of the individual rare earths. A comparison is made of total rare earth contents obtained by this and alternative procedures. (auth)

47686 (RFP-271(DR)) AN OPTICAL EMISSION SPECTROGRAPHIC METHOD FOR THE DETERMINATION OF ^{240}Pu IN PLUTONIUM MATERIALS. Vejvoda, E. (Dow Chemical Co., Denver, Colo. Rocky Flats Div.). 13 Jun 1962. Contract AT(29-1)-1106. 19p. Dep. NTIS.
Declassified 20 Oct 1971.

An optical emission isotopic spectrographic method was developed for determination of ^{240}Pu in plutonium dioxide. The analysis is based on resolution of the isotope spectral shift for ^{240}Pu using a plane grating spectrograph. (M.C.G.)

47687 (USGS-474-147) SUPPLEMENT TO PETROLOGY AND MINERALOGY OF TATUM DOME, LAMAR COUNTY, MISSISSIPPI: CHEMICAL ANALYSES. Schlocker, Julius (Geological Survey, Denver, Colo.). Jul 1972. Contract AT(29-2)-474. 7p. Dep. NTIS.

Chemical analyses were obtained of rocks from the salt stock and caprock of Tatum dome, Lamar County, Mississippi. The chemical compositions of halite and anhydritic halite rock are tabulated. Results of semiquantitative spectrographic analyses are tabulated for the same rocks as well as for water-insoluble material in the salt stock and for caprock. The chemical composition of calcite-strontianite-celestite rock and the calculated mineral composition based on it are also tabulated. (auth)

47688 DETERMINATION OF NITROGEN AND OXYGEN IN URANIUM COMPOUNDS USING THE VACUUM HOT EXTRACTION METHOD. Schneider, Helga; Nold, Eberhard (Kernforschungszentrum, Karlsruhe, Ger. Institut fuer Material- und Festkoerperforschung, Karlsruhe, Ger.). Z. Anal. Chem.; 260: No. 1, 1-4(1972). (In German).

The possibility of using a standard high-vacuum hot extraction equipment in the analysis of nitrogen and oxygen contained in uranium compounds was verified by comparison with other methods. The use of such an equipment in this field proved to be successful. Oxygen and nitrogen are extracted quantitatively at 2000°C in the presence of very pure nickel as the bath metal with the use of graphite capsules of 0.14 and 0.3 cm^3 capacity, respectively. Precise instructions are given for the determination of nitrogen and oxygen in UN, UCN, and UC. (auth)

47689 SPECTROPHOTOMETRIC METHOD FOR THE DETERMINATION OF PLUTONIUM IN FUEL SOLUTIONS. Peter, J.; Fehlmann, D.; Aerne, E. (Swiss Federal Inst. for Reactor Research, Wuerenlingen, Switzerland). J. Radioanal. Chem.; 11: No. 1, 85-90(Jun 1972).

A spectrophotometric method is described in which microgram amounts of plutonium can be determined in the presence of uranium, thorium, fission products, and cladding materials. Plutonium is extracted with TTA in xylene and reextracted into a solution of Arsenazo III. Zirconium is masked by a Fe(III)—EDTA mixture and fluoride ions by Al(III). Two to 40 μg of plutonium are required for one analysis. The standard deviation is 1.3% at 15 μg plutonium. (auth)

47690 COLORIMETRIC METHOD FOR ESTIMATION OF METHYL IODIDE RESIDUES OF JOWAR (SORGHUM) AND RICE. Rangaswamy, J. R.; Majumder, S. K.; Poornima, P. (Central Food Technological Research Inst., Mysore, India). J. Ass. Offic. Anal. Chem.; 55: No. 4, 800-1(Jul 1972).

A colorimetric method based on the catalytic action of iodide on oxidation of As(III) by Ce(IV) was developed for estimation of methyl iodide residues on grains. Methyl iodide residues, in methanolic KOH, were converted to potassium iodide, which acts as a catalyst in the timed oxidation of As(III) by Ce(IV). Unreduced ceric salt is measured colorimetrically and the iodide in the sample is calculated. The method is sensitive in the range 0.01 to 0.1 μg iodide. (auth)

47691 CHROMATOGRAPHIC SPRAYING REAGENTS FOR QUALITATIVE ANALYSIS OF INORGANIC CATIONS. Dhar, M. L.; Jain, A. C. (Univ. of Jammu, India). Curr. Sci. (India); 41: No. 15, 563-4(5 Aug 1972).

In an attempt to discover spraying reagents that would give colors with a large number of inorganic cations on paper chromatograms, various organic chelating ligands were considered. Gallacetophenone and 4,6-dihydroxy-3′,4′-dimethoxyaurone were found to be useful spraying reagents. Be, Ti, Zr, Mn, Fe, Cu, Au, Ce, Th, and U were indicated by all six spraying reagents tested with nearly similar color shades. (M.C.G.)

47692 PRECISE AND QUICK MEASUREMENT OF ISOTOPE RATIO $^{235}U/^{238}U$ USING A VARIAN MAT CH-5 MASS SPECTROMETER. Okamoto, Makoto; Nomura, Masao; Aida, Masao; Kakihana, Hidetake (Tokyo Inst. of Tech.). Shitsuryo Bunseki; 20: No. 1, 73-80(Mar 1972). (In Japanese).

A precise and quick measurement of the isotope ratio of uranium by means of a surface ionization technique was investigated using a Varian MAT CH-5 mass spectrometer. Adopting a zero-point correction and a triple filament method, the relative standard deviation of the ratio $^{235}U/^{238}U$ was reduced to 0.1%, and the measuring time was within an hour. (auth)

47693 OCCURRENCE AND ORIGIN OF LANTHANUM IN STEEL IN VIEW OF ITS APPLICATION AS AN INACTIVE TRACER IN STUDIES ON THE SOURCES OF EXOGENIC INCLUSIONS. Jaskolska, H.; Radwan, M. (Inst. of Nuclear Research, Swierk, Poland). Isotopenpraxis; 8: No. 3, 95-9(Mar 1972).

The content of lanthanum in materials during a heat of steel in a steelworks and in the steel samples was determined. It was found that the most probable source from which lanthanum passes to the steel during the heat are ferrosilicon and chamotte refractories. Some conclusions concerning the method of studying the origin of nonmetallic exogenic inclusions in steel, based on labeling refractories with inactive lanthanum, were drawn. (auth)

47694 DETERMINATION OF THE NITROGEN CONTENT AND ^{15}N ABUNDANCE BY MEANS OF THE NITROGEN GAS GENERATED FROM INORGANIC AND ORGANIC MATERIALS. Fiedler, Rudolf; Proksch, Guenter (International Atomic Energy Agency Lab., Seibersdorf, Austria). Anal. Chim. Acta; 60: No. 2, 277-85(Jul 1972).

A method is described for determination of the total nitrogen content, after conversion to nitrogen gas, of various types of samples before the mass-spectrometric analysis of the ^{15}N abundance. The sample is burned with a mixture of copper oxide, copper and lime in a closed tube under vacuum (modified Dumas method). The gas is released into an evacuated chamber of known volume and the nitrogen pressure is used to determine the nitrogen content of the sample. The gas is then admitted into a mass spectrometer. In order to obtain complete combustion of the material and to generate pure nitrogen gas, various combustion temperatures, combustion times, and oxidizing agents were compared. (auth)

47695 KINETIC ANALYSIS METHOD USING A CATALYST SYSTEM IN THE STATIONARY STATE. DETERMINATION OF I, Os, Hg, Ag, AND L-CYSTINE IN PPB—PPM RANGE. Weisz, H.; Ludwig, H. (Univ., Freiburg i. B.). Anal. Chim. Acta; 60: No. 2, 385-95(Jul 1972). (In German).

A kinetic method of analysis based on catalyzed reactions is described. The principle is as follows: to a reaction mixture containing the catalyst to be determined and a large excess of one reactant is added to the other reactant at a constant rate; the concentration of the second reactant reaches a steady-state value, which can be measured to provide a measure of the catalyst concentration. Iodide and osmium were determined in the ppB range by their catalytic effect on the cerium(IV)—arsenic(III) reaction, the cerium(IV) concentration in the steady state being determined photometrically. Mercury(II) and silver(I) prevent the catalytic action of iodide and so can be determined indirectly. L-Cystine was determined in the ppM range by means of its catalytic action on the iodine—azide reaction; the iodine concentration prevailing in the steady state was followed potentiometrically. (auth)

47696 METHOD FOR SEPARATING TRACE QUANTITIES OF CALCIUM FROM MINERALS FOR MASS SPECTROMETRY. Coleman, M. L. (Univ. of Leeds, Eng.). Anal. Chim. Acta; 60: No. 2, 426-9(Jul 1972).

An ion-exchange method was studied for separation of pure samples of calcium for isotopic analysis. The samples were decomposed using a mixture of HF and H_2SO_4. The ion-exchange columns, made of borosilicate glass, were designed to minimize the risk of aerial contamination. Calcium from this process gave good emission in solid-source mass spectrometry, which indicated a very clean separation. (M.C.G.)

47697 MICROANALYSIS OF LITHIUM BY STABLE ISOTOPE DILUTION METHOD. Okada, Satoshi; Taniguchi, Setsuo (Radiation Center of Osaka Prefecture, Sakai, Japan). Shitsuryo Bunseki; 20: No. 1, 81-4(Mar 1972).

The lithium contents of three types of aluminum samples were determined by the method of stable isotope dilution. The results obtained are as follows: 99.9% purity aluminum: $(5.5 \pm 0.3) \times 10^{-9}$ g/g, 99.999% purity aluminum: $(3.3 \pm 0.2) \times 10^{-9}$ g/g, and zone-melted aluminum: $(1.7 \pm 0.2) \times 10^{-8}$ g/g. The lithium content in the purified water and hydrochloric acid used for extraction of lithium from aluminum was also determined to be: $(1.335 \pm 0.005) \times 10^{-10}$ g/ml water, $(2.6 \pm 0.2) \times 10^{-12}$ g/ml water, $(2.6 \pm 0.2) \times 10^{-10}$ g/ml hydrochloric acid, $(5.4 \pm 0.4) \times 10^{-11}$ g/ml hydrochloric acid, and $(2.83 \pm 0.05) \times 10^{-12}$ g/ml hydrochloric acid. (auth)

47698 CHEMISTRY OF SOME GRANITIC VEINS FROM THE LEWISIAN OF COLL AND TIREE, ARGYLLSHIRE, SCOTLAND. Drury, S. A. (Univ. of Birmingham, Eng.). Chem. Geol.; 9: No. 3, 175-93(May 1972).

The chemistry of two different types of granitic rocks from a polymetamorphic Precambrian basement complex is described in the light of their metamorphic and tectonic history. Thirty-two specimens were analyzed for major oxides and S, Cr, Ni, Cu, Zn, Rb, Sr, Y, Zr, Nb, Ba, La, Ce, Pb, and Th, and are subdivided on the basis of their chemistry and origin into five groups. High grade concordant granitic veins, with abnormally high K/Rb ratios, and low K/Ba and Rb/Sr ratios, had their pattern of element distribution imparted by granulite facies metamorphism. They are shown to have been enriched in K and Rb, giving them normal values of these ratios, during a later amphibolite facies retrogressive metamorphism and deformation. Late biotite pegmatites have an unusual chemistry, showing high K/Rb, Ba/Rb, and Ba/Sr ratios opposed to their origin by fractionation of a granitic fluid, and high Ba, Zr, Th, La, and Ce contents, and low Ce/La ratios as would be found in highly fractionated granites. It is suggested that they have had a dual formative process, being initiated by selective mobilization of quartzo-feldspathic portions of the gneiss complex, and affected later by a highly fractionated fluid. (auth)

47699 MICRODETERMINATION OF MOLYBDENUM USING DITHIOL. Kobrova, Milena (Ustredni Ustav Geologicky, Prague). Chem. Listy; 66: No. 7, 768-71(Jul 1972). (In Czech).

During the determination of micro- and submicrogram concentrations of molybdenum by dithiol the conditions of extraction of molybdenum from 100 to 200 ml volumes were investigated, as well as the separation and concentration of traces of molybdenum from large volumes of samples. On the basis of partial data a simple procedure for determination of traces of molybdenum in waters was elaborated. (auth)

Radiometric and Radiochemical Procedures

Refer also to abstracts 48305—48307, 48309, and 49729.

47700 (BARC/I—144) X-RAY FLUORESCENCE IN THE ANALYSIS OF NUCLEAR FUELS: A REVIEW. Dias, R. M. A.;

Chackraburtty, D. M. (Bhabha Atomic Research Centre, Bombay (India)). 1971. 21p. INIS.

The method of x-ray fluorescence is described with reference to the principles involved, equipment required, and the various techniques of analysis followed and their applications in routine laboratory purposes. The usefulness of the method is enumerated in the field of nuclear technology particularly in the analysis of fuels. The method finds its application in the fuel reprocessing plant as a direct or on-line analysis technique. Various details are enumerated. (auth) (INIS)

47701 (DP-Report–536) METHOD FOR MEASURING THE URANIUM CONTAMINATION IN FUEL PARTICLE COATINGS. Project DRAGON. Chinaglia, B. (Atomic Energy Establishment, Winfrith (England)). Apr 1968. 18p. Dep. NTIS (U. S. Sales Only).

A technique is described for detecting uranium in fuel particle coatings. It is shown that the technique can be placed on a quantitative basis and since the sensitivity is considerably greater than obtainable with current methods, e.g., microprobe analysis. It offers scope in diffusion and coating contamination studies. (auth)

47702 (INIS-mf-262) SOME DETECTION METHODS IN RADIOCHROMATOGRAPHY AND THE MEASUREMENT OF TRITIUM AND OTHER LOW-ENERGY β EMITTERS. Prydz, S. (Oslo Univ. (Norway). Fysisk Institutt). 1971. 118p. INIS.

Reprints of ten articles resulting from a program to establish more sensitive and convenient methods for the detection and measurement of tracer activities in radiochromatography are given. The methods are adapted to paper and thin-layer separation as opposed to column separation procedures, and are largely aimed at tritium detection. Windowless gas-flow GM tubes and solid-state particle detectors are not well adapted to such measurements. An attempt was made to use an electron multiplier and this seems very promising for further development. Otherwise, the study has concentrated on scintillation techniques. Liquid scintillator techniques may involve loss of the sample and are expensive. However, among the solid scintillator materials tested were frozen liquid scintillators. The experimental procedures are described and commented upon and the separate articles summarized and discussed. (INIS)

47703 (NYO–3417-19) APPLICATIONS OF NUCLEAR AND RADIOCHEMICAL TECHNIQUES IN CHEMICAL ANALYSIS. [Progress Report, June 1, 1971–May 31, 1972]. Finston, Harmon L. (Brooklyn Coll., N. Y. Dept. of Chemistry). 1972. Contract AT(11-1)-3126. 9p. Dep. NTIS.

Information is presented in support of renewal of the grant for research on nuclear and radiochemical methods in chemical analysis. (M.C.G.)

47704 (UCRL–51061(Vol.4)) COMPUTERIZED QUANTITATIVE ANALYSIS BY GAMMA-RAY SPECTROMETRY. VOL. IV. AUXILIARY PROGRAMS FOR GAMANAL. Gunnink, R.; Niday, J. B. (California Univ., Livermore. Lawrence Livermore Lab.). 1 Jun 1972. Contract W-7405-eng-48. 38p. Dep. NTIS.

Four small programs (Efficiency, LIBETP, Linearity, and XDET) that are used in conjunction with the GAMANAL program are described. They are used to prepare a decay scheme library and to determine some of the parameters that characterize the counting systems. (auth)

47705 ENRICHMENT PROCEDURES FOR SMALL QUANTITIES OF METALS BY ORGANOMETALLIC AND OTHER COPRECIPITATION TECHNIQUES FOR X-RAY FLUORESCENCE ANALYSIS. Hirokawa, Kichinosuke (Tohoku Univ., Sendai). Z. Anal. Chem.; 260: No. 1, 4-7(1972).

Enrichment procedures for small quantities of metals, including Th, U, rare earths, Zr, and Sr, by organometallic and other coprecipitation techniques for x-ray fluorescence analysis were studied. In order to obtain a higher x-ray intensity and good reproducibility in the measurements, five requirements were considered for the coprecipitants and for the precipitate. Favorable organic precipitants are mainly alizarine blue, phenyl fluorone, and cupferron, good inorganic precipitates were fluorides and reduced metals. Other precipitation procedures can be applied to some metal elements, if the precipitation reaction is selective and a higher x-ray intensity is obtained. (auth)

47706 DETECTION OF RADIOACTIVE ACID MUCOPOLYSACCHARIDES ON ELECTROPHORESIS MEMBRANES. Herd, J. Kenneth (Univ. of New York, Buffalo. Children's Hospital, Buffalo). Anal. Biochem.; 48: No. 1, 103-11(Jul 1972).

Two methods are described for the detection of radioactivity of ^{35}S and ^{14}C on cellulose acetate membranes. The first depends on direct liquid scintillation of the dissolved membrane; it is cumbersome and inaccurate and consumes the sample. In the second, radioactivity is detected by a Nuclear-Chicago Actigraph III strip scanning radiometer using the model 106 thin-layer conveyor. Examples show the usefulness of the second method in the preliminary detection of labeled acid mucopolysaccharides following their electrophoresis on cellulose acetate support membranes. The second method is preferred for its simplicity, automation, rapidity, and accuracy although it requires slightly more isotope for satisfactory results. (auth)

47707 ALUMINUM PLANCHET COUNTING: A SIMPLE METHOD FOR IMPROVED SAMPLE SPREADING. Choules, G. L.; Guymon, Lawrence F. (Univ. of Utah, Salt Lake City). Anal. Biochem.; 48: No. 1, 307-10(Jul 1972).

Uniformity of spreading is much improved when a drop of ammonia is added to aluminum planchets before drying the sample. The method makes special drying equipment unnecessary, but is applicable only to aluminum planchets. Data employing other spreading agents are also presented. A statistical analysis is given for all of the data and several different procedures could be derived from these data depending on the needs of the user. (auth)

47708 PHOSPHORYLATION ASSAY IN LIQUID SCINTILLATION COUNTER USING CHERENKOV RADIATION OF ^{32}P: APPLICATION TO PHOTOPHOSPHORYLATION. Asada, Kozi; Takahashi, Masa-aki; Urano, Mieko (Kyoto Univ.). Anal. Biochem.; 48: No. 1, 311-15(Jul 1972).

A simple procedure is described for the assay of phosphorylation using Cherenkov radiation to detect ^{32}P in a liquid scintillation counter. Unreacted $^{32}P_i$ is first removed from the reaction mixture as the phosphomolybdate complex by butanol/benzene extraction. Addition of ammonium hydroxide to the remaining aqueous fraction avoids color quenching, phase separation, and instability in the counting rate during measurement of ^{32}P. Application of this procedure to several photophosphorylation systems is included. (auth)

47709 SENSITIVE METHOD FOR DETERMINING PREFERENTIAL BINDING OF SUBSTANCES TO ENZYMES AND BIOLOGICAL MEMBRANES. Moeller, Jesper V. (Univ. of Aarhus, Denmark). Anal. Biochem.; 47: No. 2, 337-47(Jun 1972).

A systematic study of the factors that affect the channel ratio as measured by liquid scintillation counting was carried out. It was found that a change in the channel ratio of about 0.2% can be detected when proper corrections for quenching were applied. The applicability of the method was demonstrated by an examination of the stereospecific binding of D-glucose to hexokinase. Variations of counting results on tritium and ^{14}C for different vials are given. Reasons for the different channel ratios, errors in dispensing of radioactive solution and scintillator fluid, presence of quenching impurities in vials, and different spectral properties of the vials are considered. A three-channel procedure was devised to correct for the different counting properties of the vials. (M.C.G.)

47710 DETERMINATION OF ^{35}S-LABELED COMPOUNDS OF AQUEOUS IONIC SOLUTIONS BY LIQUID SCINTILLATION COUNTING. Tonzetich, J. (Univ. of British Columbia, Vancouver). Anal. Biochem.; 47: No. 2, 584-91(Jun 1972).

The application of a filter paper method for β-scintillation counting of aqueous ^{35}S-containing preparations in a nonpolar scintillation solvent system is described. A specific procedure is outlined for recovering 99.5% of $^{35}SO_4$ from saliva supernate containing an assortment of sulfur compounds. The assay yielded 90% efficiency in ^{35}S counting and exhibited excellent stability. The filter paper method possesses several salient features that make it especially useful for studying sulfur metabolism of a putrefaction system, such as incubated saliva. It presents a convenient and accurate means of determining the nonvolatile, polar, and nonpolar ^{35}S content of biological systems. (auth)

47711 INVESTIGATION OF LOW-ENERGY ION SCATTERING AS A SURFACE ANALYTICAL TECHNIQUE. Ball, D. J. (Bell Telephone Labs., Inc., Allentown, Pa.); Buck, T. M.; MacNair, D.; Wheatley, G. H. Surface Sci.; 30: No. 1, 69-90(Mar 1972).

Energy spectra of rare gas ions backscattered from various solids were monitored for primary energies in the range 0.5 to 40 keV. At the higher primary energies, peaks in the backscattered energy spectrum, which correspond to the masses of atoms on the sample surface, tend to broaden considerably towards lower energies. As the primary energy is reduced, these peaks become sharp, and below 5 keV primary energy the technique is suitable for elemental surface analysis of solids, including polycrystals and amorphous materials. The sensitivity of the apparatus to trace impurities was estimated by examination of precalibrated test samples and is found to be ~5×10^{-4} monolayers for a heavy element such as gold, and by extrapolation ~10^{-1} to 10^{-2} monolayer for oxygen. Sputtering by low-energy helium-ion beams is found not to be a serious problem during analysis. Argon-ion beams, on the other hand, may be used to study depth profiles of composition in alloys. (auth)

47712 SMALL-ANGLE MULTIPLE REFLECTION OF LOW-ENERGY (6 keV) NOBLE-GAS IONS FROM SINGLE-CRYSTAL SURFACES AS A MEANS TO STUDY SURFACE TEXTURE AND CONTAMINATION. Begemann, S. H. A.; Boers, A. L. (State Univ., Groningen, Netherlands). Surface Sci.; 30: No. 1, 134-60(Mar 1972).

The elemental composition of a surface can be derived from the energy spectrum of singly reflected noble gas ions. It is shown that it is also possible to obtain information about certain structural features on the surface from the energy spectra of multiply reflected ions. By carefully studying the multiple reflection energy spectra when the angle of incidence ψ is varied at a given scattering angle θ, many different multiple reflection peaks can be resolved and identified. The ideal conditions for measurements on atomically clean and undisturbed surfaces were closely approached by working with a low residual gas pressure (10^{-10} torr) in the collision chamber and small primary ion current densities (<10^{-8} A/cm^2). For Ar$^+$ and Kr$^+$ on (100)-Cu, peaks were found resulting from an ideal, flat surface and peaks resulting from surface ridges (steps) and surface vacancies. This technique opens possibilities to study nucleation and early stages of growth of thin films, surface defect formation as a result of ion bombardment, the annealing behavior of surface defects, thermal vibrations of surface atoms, and neutralization processes in multiple collision sequences. (auth)

47713 APPLICATION OF SOLID SCINTILLATORS IN HIGH-SPEED RADIO COLUMN CHROMATOGRAPHY. CONSTRUCTION OF A SIMPLE FLOW CELL. Sieswerda, G. B.; Polak, H. L. (Univ., Amsterdam). J. Radioanal. Chem.; 11: No. 1, 49-58(Jun 1972).

The construction of a flow cell suitable for measurement of weak β-radioactivity is described. The relative efficiencies of several commercially available scintillators for ^{14}C and tritium were determined. POPOP appears to possess the best properties and is used for the detector tests, viz. the determination of the absolute efficiency, the peak broadening, and the calibration curves. The separation of a mixture of ^{14}C-labeled amino acids shows the performance in high-speed chromatography. (auth)

47714 RADIOCHEMICAL ANALYSIS OF $^{35}SO_2$ ADSORBED ON PbO_2. Durham, Jack L. (National Environmental Research Center, Research Triangle Park, N. C.); Wagman, Jack; Fish, B. R.; Seeley, F. G. Anal. Lett.; 5: No. 7, 469-78(1972).

The concentration of $^{35}SO_2$ in air can be measured by reacting with PbO_2 to form $Pb^{35}SO_4$. A method was developed that is suitable for rapid, high-precision radioassaying of $^{35}SO_4^{2-}$ on the surface of PbO_2. The surface $^{35}SO_4^{2-}$ was extracted with a quaternary alkylammonium hydroxide in toluene and counted in an organic liquid scintillator solution with an efficiency of approximately 94%, which was constant for 30 days when corrected for natural decay. More than 99.5% of the surface sulfate was extracted in less than 5 minutes for quaternary alkylammonium concentrations 600 times in excess. This technique was shown superior to gas-flow proportional counting of the PbO_2 surface. (auth)

47715 COMPARISON OF THE ENERGY SPECTRA OF CHEMILUMINESCENCE, PHOSPHORESCENCE, ^{14}C, AND TRITIUM, RECORDED WITH A LIQUID SCINTILLATION SPECTROMETER. Kalbhen, D. A. (Rheinische Friedrich-Wilhelms Univ., Bonn); Tarkkanen, V. Kerntechnik; 14: No. 6, 272-5(Jun 1972). (In German and English).

With a combination of a liquid scintillation counter and a multichannel analyzer, it is possible to record energy spectra of radionuclides as well as of chemiluminescence and phosphorescence reactions. A comparison of the magnitude and shape of the energy spectra of ^{14}C, ^{3}H, chemiluminescence reactions, and phosphorescence reaction shows clearly that chemiluminescence results in disturbances, especially in measurements of tritium activity. The overlapping of the energy spectra makes impossible a quantitative differentiation between chemiluminescence pulses and radioactivity pulses in a liquid scintillation counter. It is also shown that, if the chemiluminescence reaction is very intensive, piling up effects at the photocathode result in the recording of pulses with spuriously high energies reaching far into the ^{14}C energy spectrum. With liquid scintillation counting, disturbing pulses from chemiluminescence reactions cannot be eliminated either by altering the measurement range or by the use of the channel ratio method. (auth)

47716 DETERMINATION OF INORGANIC RADIOIODIDES IN ^{131}I LABELED COMPOUNDS BY MEANS OF INSTANTANEOUS THIN LAYER CHROMATOGRAPHY. de Salas, G. N. Bianco; Alvarez, J.; Mitta, A. E. A. (Comision Nacional de Energia Atomica, Buenos Aires). Radiochim. Acta; 17: No. 1, 58(May 1972).

The list of organic compounds that can be analyzed by this method was extended. (M.C.G.)

47717 RADIOCHEMICAL MEASUREMENT OF ELECTRON CONCENTRATION IN SEMICONDUCTOR MATERIALS. Schwabe, K.; Thiemt, K. (Technische Univ., Dresden). Isotopenpraxis; 8: No. 4, 139-43(Apr 1972). (In German).

A method of determination of electron concentration in solid matter was developed. It provides solution of the matter in tritium water or a tritium-labeled acid with subsequent determination of the activity of the hydrogen produced by the electrons in a process running: $e^-_{aq} + H_3^* + O \rightarrow H^* + H_2^*O$(k ≈ 2.3×10^{10} l mol^{-1} s^{-1}) and $H^* + H^* \rightarrow H_2^*$ (k ≈ 1.3×10^{10} l mol^{-1} s^{-1}) by means of a gas counter. The detector renders possible detection of electrons up to 8×10^{-11} mol. The electron concentration was determined for CdS, ZnO, CdO, HgO, and radiation-discolored sodium chloride samples. The results are well in conformity with the results of other measurements. (auth)

47718 INDIRECT DETERMINATION OF K^+ AND NH_4^+ BY β^- RADIATION ABSORPTION. Marcu, Gh.; Sacelean, V. (Chemical Inst., Cluj). Rev. Roum. Chim.; 17: No. 4, 705-9(Apr 1972). (In German).

Solutions were prepared from the precipitates $Me_2^IPb[Me^{II}(NO_2)_6]$ where $Me^I = K^+$ and NH_4^+, Ni^{2+}, and Cu^{2+}. Based on β absorption by the solutions, two indirect methods were elaborated for determination of K^+ and three for NH_4^+. Statistical evaluation of the experimental results showed that the method of determination had the same degree of position for 0.070 to 0.294 g K^+ and 0.0323 to 0.1357 g NH_4^+, respectively, in their chloride solutions. (tr-auth)

47719 APPLICATION OF THE ELASTIC SCATTERING OF HELIUM IONS TO THE ANALYSIS OF SURFACES OF LENSES. Heitz, Ch.; Larcher, J. (Univ. Louis Pasteur, Strasbourg). Radiochem. Radioanal. Lett.; 11: No. 1, 29-37(31 Jul 1972). (In French).

The chemical composition of the surfaces of lenses was determined by scattering of 6-MeV helium ions. The analysis reveals a thin metallic layer covered with a SiO_2 layer at the concave faces of the glasses. (auth)

Separation Procedures

Refer also to abstracts 47864, 47920, 47923, 47924, 47940, and 49452.

47720 (BM-RI-7663) EXTRACTION PROCESS FOR UPGRADING Sm_2O_3 USING SELECTIVE STRIPPING TECHNIQUES. Bauer, Donald J.; Schultze, L. E.; Lindstrom, R. E. (Bureau of Mines, Reno, Nev. Reno Metallurgy Research Center). 1972. 9p.

A solvent-extraction system employing selective stripping of a preloaded organic phase was investigated for recovering Sm_2O_3 from a light-group rare earth mixture. The samarium concentrated in the organic phase, and a >99% pure samarium oxide product was obtained at 76% recovery in a 20-stage operation using bis(2-ethylhexyl) phosphate as the organic phase. The stripping agent was a 1.5% hydrochloric acid solution containing 200 g NH_4Cl/l. (auth)

47721 (INP-799) SOLVENT EXTRACTION OF ACTINIDE AND LANTHANIDE ELEMENTS BY QUATERNARY AMMONIUM SALTS. III. EXTRACTION OF LANTHANIDE AND TRANSPLUTONIUM ELEMENTS IN SYSTEMS CTMAB-$LiNO_3$ AND CPB-$LiNO_3$. Sheglovski, Z.; Gavrilov, K. A.; Kim Yun Bon; Mikul'ski, Ya.; Om San Ik (Institute of Nuclear Research, Krakow (Poland)). 1972. 15p. (In Russian). Dep. NTIS (U. S. Sales Only).

The extraction of light rare earth elements and americium and curium from solutions of lithium nitrate in 0.01 N nitric acid, by means of solutions of cetyltrimethylammonium bromide and cetylpyridinium bromide in chloroform was studied. The distribution coefficients of lanthanide elements increased linearly with the concentration of lithium nitrate. The values of the distribution coefficients decreased with increasing atomic number. The solvation number for light lanthanides and the separation factors for adjoining pairs of elements were determined. The solvation number for all examined elements was equal to about 2. The separation factors for the pairs Pm–Sm, Sm–Eu and Am–Cm were greater than 2. (auth)

47722 (INR-1393) TRENDS IN THERMODYNAMIC FUNCTIONS ASSOCIATED WITH THE EXTRACTION OF LANTHANIDES

IN THE HDEHP–HNO_3 SYSTEM. Fidelis, Irena (Institute of Nuclear Research, Warsaw (Poland)). 1972. 22p. (In Polish). Dep. NTIS (U. S. Sales Only).

Relative changes in the free energy and entropy accompanying extraction of lanthanides in the DEHPA – HNO_3 system were determined. The general trends in the thermodynamic functions observed for DEHPA were compared with these for other complexing agents. The trends in the changes of $\Delta H°$ and $\Delta S_i°$ for DEHPA as functions of Z were similar to those observed for DCTA. It was also observed that in the Pu – Lu range the dependence of $\Delta H°$ on Z shows the effect of regularity (double-double effect) for all organophosphorus extractants. (auth)

47723 (INR-P–1395) EFFECT OF RESIN CROSS-LINKING ON THE ANION EXCHANGE SEPARATION OF RARE EARTH COMPLEXES WITH DCTA. Wodkiewicz, Ludmila; Dybczynski, Rajmund (Institute of Nuclear Research, Warsaw (Poland)). 1972. 24p. Dep. NTIS (U. S. Sales Only).

Anion exchange of the rare earth complexes with DCTA in the system: Dowex 1 $[H_2Z^{2-}]-Na_2H_2Z$ was investigated on resins of 2, 4, 8, 10, and 16 nominal cross linking, respectively. Selectively coefficients, separation factors and especially plate heights and resolutions were found to depend markedly on resin crosslinking. As in the case of anion exchange separation of rare earth complexes with EDTA, also in this system longitudinal diffusion in the stationary phase was shown to contribute significantly to plate height. The existence of sieve effect towards complex ions in the case of highly crosslinked resins was ascertained. Direct comparison of ion exchange affinity of the lanthanide – EDTA and lanthanide – DCTA complexes in the system: Dowex $1X4[Cl^-]$ – NaCl aq. seemed to confirm the previously suggested hypothesis of gradual changes in the structure of complex ions with the variation of central atom radius. (auth)

47724 DEVELOPMENT OF A REACTOR FOR THE THERMAL DESTRUCTION OF AMMONIUM NITRATE IN VIEW OF RECOVERING ^{137}Cs. Mora, J. C. (Institut de Genie Chimique, Toulouse). Energ. Nucl. (Paris); 14: No. 1, 38-44(1972). (In French).

The recovery of ^{137}Cs using ion exchange resins requires the thermal destruction of eluate solutions. Aqueous ammonium nitrate solutions (NH_4NO_3) are the most efficient eluates, although up until now the explosive risks associated with the thermal instability of NH_4NO_3 have deterred their use in favor of ammonium acetate solutions. A liquid film decomposition reactor is proposed for the continuous thermal destruction of NH_4NO_3 solutions. A stationary steady-state explosive region obtained using a liquid film is employed in the operating region. A quantity of solution equivalent to 230 kg of crystallized NH_4NO_3 was treated without any incident. The solutions were completely transformed into a gaseous phase containing NH_3, HNO_3, H_2O, N_2, O_2, N_2O, NO, and NO_2. The composition of this gas mixture is a function of the working conditions. The apparatus may be used for various destruction and elution processes. (France)

47725 DISTRIBUTION OF URANIUM(IV) BETWEEN AQUEOUS NITRIC ACID AND ORGANIC SOLUTIONS OF THE NITRATE SALT OF THE SECONDARY AMINE AMBERLITE LA-1. Schmid, E. R.; Juenger, E. (Univ., Vienna). J. Radioanal. Chem.; 11: No. 1, 35-47(Jun 1972). (In German).

The nitrate salt solution of the secondary amine Amberlite LA-1 in organic solvents extracts uranium(IV) from aqueous nitric acid solutions. The distribution ratio of uranium(IV) reaches a maximum at an equilibrium nitric acid concentration of 8.5M in the aqueous phase. Addition of n-octanol to the organic phase decreases, and the addition of nitrate to the aqueous phase increases the uranium(IV) distribution ratio. The extraction of uranium(IV) is fast and the equilibrium distribution is reached within less than one minute. At low uranium(IV) concentrations ($\leq 6 \cdot 10^{-3}$M) the distribution ratio is independent of the uranium(IV) concentration. At high uranium(IV) loadings of the organic phase an extrapolation gives a mole ratio of amine : uranium(IV) = 2 : 1. A double logarithmic plot of the dependence of the uranium(IV) distribution ratio vs the LA-1 concentration in the organic phase gives a curve with a slope of two when polar diluents for LA-1 are used. This slope of two and the shapes of the absorption spectra of the organic phase from 400 to 700 nm make it very probable that uranium(IV) exists in the organic phase as a hexanitrato complex. (auth)

47726 SOLVENT EXTRACTION BEHAVIOR OF TRIVALENT METALS WITH LIQUID ION EXCHANGERS. De, Anil K.; Ray, Uday Sankar (Visva-Bharati, Santiniketan, India). Separ. Sci.; 7: No. 4, 409-17(1972).

A systematic liquid – liquid extraction behavior of some trivalent metals was studied using the high-molecular-weight synthetic carboxylic acid SRS-100 with benzene as diluent. In most cases extraction was quantitative; but in the cases of gallium and antimony the maximum extraction was 97.2 and 65%, respectively. Using pure solvent (without benzene diluent), quantitative extraction (>99%) of gallium was possible with SRS-100 at pH 4.6. Gradual neutralization techniques were adopted to study the extraction behavior of antimony in the pH range 2.0 to 6.5. The effects of metal ion concentration, solvent concentration, salting-out agents, diluents, and the interferences of associated elements were critically examined. The percentage extraction at various ranges of pH was also studied. Some important separations were carried out by exchange reactions. The proposed methods are very simple, rapid, and fairly selective. They can be carried out both at micro and macro levels. (auth)

47727 SOLVENT EXTRACTION BEHAVIOR OF CERIUM(IV), ZIRCONIUM, AND THORIUM WITH LIQUID ION EXCHANGERS. De, Anil K.; Ray, Uday Sankar (Visva-Bharati, Santiniketan, India). Separ. Sci.; 7: No. 4, 419-24(1972).

The systematic solvent extraction behavior of cerium(IV), zirconium, and thorium was studied with high-molecular-weight carboxylic acids SRS-100 and Versatic-9, with benzene as diluent. Quantitative extraction was achieved in almost all cases. Only in the case of zirconium was incomplete extraction (73.5%) reported with Versatic-9. Quantitative extraction requires three consecutive equilibrations at pH 2.9. The effect of metal ion concentration, solvent concentration, diluents, and the interference of the associated elements were critically examined. The percentage extraction at various ranges of pH was studied. Exchange reaction techniques were employed in several systems. The proposed methods are very simple, rapid, and fairly selective. They can be carried out both at micro and macro levels, and they are applicable to extraction of metal ions in the presence of other commonly interfering ions. (auth)

47728 SEPARATION OF LANTHANIDES BY CHROMATOGRAPHY ON ION EXCHANGE PAPER SA-2. III. SEPARATION OF THE YTTRIUM EARTHS. Dubuquoy, C.; Gusmini, S.; Poupard, D. (CEA, Bruyeres le Chatel, France). J. Chromatogr.; 70: No. 1, 216-19(26 Jul 1972). (In French).

Chromatographic separation of the yttrium earths was studied using SA-2 paper with ammonium lactate and $\alpha H \alpha MB$ (ammonium salt of 2-hydroxy-2-methylbutyric acid). Optimum conditions are proposed using the lactate and lactate – $\alpha H \alpha MH$ mixtures. Chromatograms are given for the separation of Eu, Tb, Y, Ho, Er, Tm, Yb, and Lu under various conditions. (J.G.B.)

47729 FAST RADIOCHEMICAL PROCEDURE FOR SEPARATING GERMANIUM FROM FISSION PRODUCTS. Del Marmol, P.; Van Tigchelt, H. (CEN/SCK, Mol, Belgium). Radiochim. Acta; 17: No. 1, 52-4(May 1972).

An attempt was made to extract germanium as gaseous $GeCl_4$ from mixed fission products and stop it in a one-step method. A solution containing uranium and fission products is poured into a HCl solution and Cl_2 is bubbled through. The gas is sucked out, dried, and passed on 40 to 200 mesh Zn, which stops the germanium. The method is normally limited to experiments leading to γ measurements, as β particles would be partly absorbed in the Zn. (M.C.G.)

47730 SORPTION OF MICROQUANTITIES OF ZIRCONIUM AND NIOBIUM BY AMMONIATED MOLYBDATOPHOSPHATE. Hermann, A.; Baraniak, L. (Zentralinstitut fuer Kernforschung, Rossendorf, Ger.). Isotopenpraxis; 8: No. 3, 106-10(Mar 1972). (In German).

The behavior of microquantities of ^{95}Zr and ^{95}Nb on ammoniated molybdatophosphate (AMP) as an anorganic ion exchanger was investigated. The dependance of distribution ratio on HNO_3 concentration and on the addition of the normal salts $NaNO_3$ and NH_4NO_3 allow the conclusion that the sorption of microquantities of ^{95}Zr or ^{95}Nb on AMP is based on the adsorption of hydrolyzed and polymerized forms. The effect of oxalic acid, tartaric acid, citric acid, EDTA, hydrofluoric acid, and sulfuric acid as complexing agents on the sorption process was studied. The nature of the hydrolyzed forms was explored. (auth)

47731 SOLVENT EXTRACTION OF SOME DIPROTIC NITROAROMATIC METAL COMPLEXES FROM NITRIC ACID SOLUTIONS BY TRI-n-BUTYLPHOSPHATE. Kopecni, M. M. (Boris Kidric Inst. of Nuclear Sciences, Belgrade); Secerov, M. M.; Maksimovic, Z. B.; Beran, M. Bull. Boris Kidric Inst. Nucl. Sci., Chem.; 22: No. 3, 17-22(Oct 1971).

Solvent extraction of 3,5-dinitrosalicylic (H_2 3,5-DNSal) and 4-nitrophenol-2-sulfonic (H_2 4-NPh-2-S) acids and of their Pu^{4+} and UO_2^{2+} complexes from the nitric acid (0.4M) medium with TBP in n-dodecane was investigated. The composition of the prevailing extractable species was determined by slope analysis. (auth)

47732 THIN-LAYER CHROMATOGRAPHIC BEHAVIOR OF A NUMBER OF TRANSITION METALS ON DEAE-CELLULOSE IN AZIDE/CHLORIDE MEDIA. Kuroda, Rokuro; Kojima, Nobuo; Oguma, Koichi (Univ. of Chiba, Japan). J. Chromatogr.; 69: No. 1, 223-6(28 Jun 1972).

Thin-layer chromatographic techniques were used with DEAE-cellulose as the adsorbent in aqueous sodium azide—hydrochloric acid mixtures as well as in mixed aqueous azide—chloride—organic solvent (methanol) media to study metal ions including Mo, Nb, Sc, Sm, Th, U, and Zr. R_f values are given. (M.C.G.)

47733 REVERSED-PHASE EXTRACTION CHROMATOGRAPHY USING Br^--CONTAINING ELUANTS. Brinkman, U. A. Th.; de Vries, G.; Leene, H. R. (Free Reformed Univ., Amsterdam). J. Chromatogr.; 69: No. 1, 181-93(28 Jun 1972).

Forty-three ions including rare earths, Y, Th, Mo, Zr, were chromatographed on thin layers of silica gel impregnated with Alamine 336, Amberlite LA-I, Primene JM-T, Alamine oxide (AlamO), tri-n-octylphosphine oxide (TOPO) or tri-n-octylarsine oxide (TOAsO), and on nonimpregnated silica gel using aqueous HBr and acidified LiBr solutions as eluants. The R_F spectra and a number of separations are reported. Percentage extraction versus M Br^- data and preliminary results of spectroscopic measurements for the system: extractant—Co(II)—Br^- are also recorded. The behavior of each of the six extractant—Br^- systems investigated resembles that of the corresponding chloride system. The sorption strength increases in the order: Primene < Amberlite ≤ AlamO ≤ Alamine. The strength of TOPO is comparable to that of Alamine for a large majority of the ions studied; the remaining ions are strongly sorbed on TOPO-impregnated silica gel, whereas sorption is weak in the case of Alamine. The behavior of TOAsO distinctly deviates from that of all other extractants; the preferential uptake of a second molecule of HBr plays a decisive role here. Sorption proceeds through anion-exchange with the amines and, probably, also with AlamO. With TOPO, both solvation and anion-exchange appear to play a role. (auth)

47734 STUDY OF SELECTIVE EXTRACTION OF TANTALUM INTO DIBUTYL BUTYLPHOSPHONATE, WITH THE AID OF FIRST- AND SECOND-ORDER EXPERIMENTAL DESIGNS. Chernyak, A. S.; Teploukhova, L. K.; Druzhina, G. Ya.; Popyalkovskii, Yu. K. (Irkutsk State Scientific-Research Inst. of Rare and Nonferrous Metals, USSR). J. Appl. Chem. USSR (Engl. Transl.); 45: No. 2, 327-32(Feb 1972).

Translated from Zh. Prikl. Khim.; 45: No. 2, 332-8(Feb 1972).

Investigations with the aid of first- and second-order experimental designs confirm results obtained earlier in an experimental study of selective extraction of tantalum, reveal new characteristics of the process, and make it possible to define its limits more closely. The position of the region of minimum extraction of niobium depends little on the ratio of the tantalum and niobium pentoxide contents in the original solution and is determined by the ratio S : E = 3 : 1 to 5 : 1 and $\Sigma(Ta, Nb)_2O_5 = 90-120$ g/liter, while the position of the region of maximum extraction of tantalum depends significantly on the $Ta_2O_5 : Nb_2O_5$ ratio; decrease of this ratio improves separation. At $Ta_2O_5 : Nb_2O_5 \leq 1 : 5$ in the region of high selectivity extraction of tantalum is not affected by variations of the metal concentrations in solution. The influence of accidental variations of conditions on the process can be assessed from lines of equal extraction. (auth)

47735 INTENSIFICATION OF THE AUTOCLAVE SODA LEACHING PROCESS FOR TUNGSTEN—MOLYBDENUM CONCENTRATES. Perlov, P. M.; Poprukailo, V. M. Tsvetn. Metal.; No. 3, 79-81(Mar 1972). (In Russian).

Plant processing of W—Mo concentrates requires a 4-hr leaching step at 200 to 225°C. The mineralogical content of a typical specimen was: 50% scheelite, 9.5% powellite, 0.3% molybdenite, 0.2% pyrrhotine + sphalerite, 18% fluorite, 12% calcite, 1.7% apatite, and 8% quartz + pyroxene. The approximate equivalent chemical content was 44% WO_3, 4.5% Mo, 9% F, 5% SiO_2, 0.7% MgO, and 33% CaO (the remainder "R_2O_3"). Autoclave experiments used two "soda equivalents" and were conducted at 225, 250, 270, 280, and 300°C (50 to 64 min). The results indicated that a short-time leaching at elevated temperatures (280 to 300°C) is advisable for low-grade W—Mo concentrates. (K.S.W.)

47736 EKSTRAKTSIYA NEORGANICHESKIKH VESHCHESTV. (Extraction of Inorganic Substances). Nikolaev, A. V. (ed.). Novosibirsk, USSR; Izdatel'stvo Nauka Sibirskoe Otdelenie (1970). 340p.

Extraction equilibria of simple and polycomponent systems, the problems of thermochemistry and thermodynamics, and phase equilibria and extractive capability during isolation of inorganic substances are covered. Diagrams of distribution, separation, and salting out are given. Separation diagrams are included for Ce, Th, La, U, and Zr. (M.C.G.)

Inorganic, Organic, and Physical Chemistry

Refer also to abstract 48355.

47737 (LBL—425, pp 1-82) CHEMISTRY. Apr 1972. In Inorganic Materials Research Division annual report, 1971.

Research progress is reported in very brief summaries on: inorganic chemistry, solid-state chemistry and physics, electrochemistry, physical chemistry, and nuclear science. Abstracts of and references to publication of the research, either as reports or in the open literature, are included at the end of each broad category. (M.C.G.)

Chemical and Physico-chemical Properties

Refer also to abstracts 48038, 48161, 48403, 48414, 48890, and 49183.

47738 (ANL—7921) CHEMICAL ENGINEERING DIVISION, THERMOCHEMICAL STUDIES SEMIANNUAL REPORT, JANUARY—JUNE 1972. Hubbard, W. N.; Johnson, G. K.; Ader, M.; Settle, J. L.; O'Hare, A. G.; Tevebaugh, A. D.; Vogel, R. C. (Argonne National Lab., Ill.). Jun 1972. Contract W-31-109-eng-38. 24p. Dep. NTIS.

Final values for $\Delta H_f^\circ(Na_2C_2, c, 298°K)$ and $\Delta H_f^\circ(NaHC_2, c, 298°K)$ were determined to be $+4.80 \pm 0.40$ and $+23.10 \pm 0.27$ kcal mol^{-1}, respectively. Combination of the value for Na_2C_2 with measurements of the heat capacity and solubility in sodium of Na_2C_2 indicate that Na_2C_2 is an important species formed when graphite is dissolved in liquid sodium. Determination of the enthalpy of formation of monocesium acetylide by solution calorimetry in a similar study yielded the value $\Delta H_f^\circ(CsHC_2, c, 298°K) = +18.84 \pm 0.27$ kcal mol^{-1}. Measurements of the enthalpies of solution of Cs_2O and ThS yielded values of the standard enthalpies of formation at 298°K for these compounds, in kcal mol^{-1}, as follows: $\Delta H_f^\circ(Cs_2O, c) = -82.52 \pm 0.18$ and $\Delta H_f^\circ(ThS_{1.029\pm0.019}, c) = -96.9 \pm 0.9$. Carbide samples are being prepared for enthalpy of formation studies by fluorine bomb calorimetry. (auth)

47739 (GAT-T—1854) IRON AS A SCAVENGER IN FLUORINE DISPOSAL. Reiter, N. F. (Goodyear Atomic Corp., Piketon, Ohio). 8 May 1972. Contract AT(33-2)-1. 10p. Dep. NTIS.

Laboratory tests were conducted to evaluate the iron—fluorine reaction as a possible basis for chemically scrubbing fluorine from gaseous mixtures to be vented to the atmosphere. Iron in the form of coarse steel wool packed into a cylindrical nickel reactor was found to consume nearly all the fluorine from fluorine—oxygen and fluorine—nitrogen mixtures containing from 0.5 to 100% fluorine. External heat to the reactor was required to assure reaction at the lower fluorine concentrations. Gaseous fluorides found in the emitted reaction products ranged from less than one to 15 ppM. Gaseous products from the reactions of fluorine—oxygen mixtures with iron were less than 3% of the volume of gases fed into the reactor. The exit gas was essentially nitrogen, which indicates that oxygen also reacts with the iron. No toxic gaseous products were emitted, and the solid products were nonvolatile and totally contained the fluorine for long-term storage or disposal in a small volume. These reactions appear to be useful for scavenging fluorine from gaseous emissions using a temperature-controlled reactor containing low cost steel chips or shavings. (auth)

47740 (UCRL-Trans—10636) REDOX POTENTIALS AND ELECTRONIC STRUCTURE. I. 3d, 4d, AND 5d TRANSITION ELEMENTS. David, F. Translated for Univ. of California Lawrence Livermore Lab., Livermore, from report RC—71.05. 31p. Dep. NTIS.

A systematic study was made of the variation of free enthalpy $\Delta G^0 = XE^0$ relative to the reactions $M(X) + Xe^- = M(0)$. This makes it possible to compare the thermodynamic stability of the various degrees of oxidation of a given element as well as that of the oxidation state for different elements. Frost diagrams $[\Delta G^0 = f(X)]$ were established for different elements and the variations of the stability of the various degrees of oxidation of elements of one and the same transition series were observed. A relationship between oxido-reducing properties of the 3d, 4d, and 5d transition elements and their electronic structure was ascertained. (M.C.G.)

47741 HYDROGEN—OXYGEN REACTION ON LANTHANIDE OXIDES. II. THE STOICHIOMETRIC HYDROGEN—OXYGEN RE-

ACTION ON NEODYMIUM OXIDE, DYSPROSIUM OXIDE, AND ERBIUM OXIDE. Read, John F.; Conrad, Reid E. (Mount Allison Univ., Sackville, New Brunswick). J. Phys. Chem.; 76: No. 16, 2199-2206(3Aug 1972).

The reaction between a stoichiometric mixture of hydrogen and oxygen was studied over neodymium oxide, dysprosium oxide, and erbium oxide catalysts. The reaction was studied over neodymium oxide in the temperature range 68 to 150°C at pressures from 0.68 to 14.22 Torr, over dysprosium oxide in the temperature range 85 to 150°C at pressures from 2.04 to 3.20 Torr, and over erbium oxide in the temperature range 109 to 191°C at pressures from 0.20 to 9.17 Torr. The kinetics over all three oxides obeyed a similar pattern. Below a certain temperature the kinetics were zero order, and above this temperature the apparent order changed during the course of each reaction from zero to a value in the range 0.5 to 1. The results are explained in terms of a general kinetic expression based on the Langmuir isotherm, namely $-dP_T/dt = (A_m P_T)^m/(1 + BP_T)^m$, where A_m and B are temperature-dependent constants, P_T is the total pressure of hydrogen plus oxygen, and m is an integer of value 1 to 3. The best fit between experimental and theoretical data was obtained when m = 1. The most likely mechanism is one that involves the fraction of active surface covered by molecular hydrogen as a rate-determining step. (auth)

47742 ACIDIC PROPERTIES OF $ZnO.As_2O_3$, $ZnO.Sb_2O_3$, $ZnO.Bi_2O_3$, $ZnO.ZrO_2$, AND $ZrO_2.ThO_2$ AND CATALYTIC ACTIVITY OF $ZnO.Bi_2O_3$ FOR ALKYLATION OF PHENOL WITH METHANOL. Tanabe, Kozo; Ichikawa, Ichiro; Ikeda, Hiroko; Hattori, Hideshi (Hokkaido Univ., Sapporo). J. Res. Inst. Catal., Hokkaido Univ.; 19: No. 3, 185-92(1971).

The mixed oxides were prepared and their acidic and basic properties were qualitatively measured and the effects of composition and calcination temperature on acidic and basic properties were also studied. Among five mixed oxides, $ZnO \cdot Bi_2O_3$, which showed highest acidity, was tested for its catalytic activity for the alkylation of phenol with methanol. (M.C.G.)

47743 SOLVATION MODEL FOR NON-METALS IN LIQUID ALKALI METALS. Thompson, R. (United Kingdom Atomic Energy Authority, Harwell, Eng.). J. Inorg. Nucl. Chem.; 34: No. 8, 2513-22(Aug 1972).

A model was developed assuming nonmetals are present as ionic species in solution. The effect of the ion on the metal solvent surrounding it is discussed and the solvation energy calculated by considering the electrostatic forces set up around the solute ion. The model predicts the solvation energies of the halogens in alkali metal solvents and the calculated values agree well with those derived from experimental data. The model was used to examine solutes other than the halogens, namely oxygen, nitrogen, carbon and hydrogen, with the aim of suggesting the form in which they exist in solution. (auth)

47744 ADSORPTION OF Co^{2+} BY OXIDES FROM AQUEOUS SOLUTION. Tewari, P. H.; Campbell, A. B.; Lee, W. (Atomic Energy of Canada Ltd., Pinawa, Manitoba). Can. J. Chem.; 50: No. 11, 1642-8(1 Jun 1972).

The transport of cobalt adsorbed on corrosion product oxides seems to be an important factor in the growth of reactor radiation fields. The adsorption of Co(II) by Fe_3O_4, Al_2O_3, and MnO_2 was studied as a function of Co(II) concentration, solution pH, and temperature. Adsorption of cobalt increased markedly with the solution pH between 5 and 7.5. Above pH 8 adsorption became increasingly masked by precipitation of $Co(OH)_2$ and no resolution of these two contributions to the loss of Co(II) from solution was possible. A log $\theta/(1 - \theta)$ vs. pH plot was linear between pH 5 and 7.5, where θ is the fraction of occupied adsorption sites. The presence of 0.1 m Ba^{2+} and Mg^{2+} in the solution does not seem to affect the hydrogen ion dependence of the adsorption of Co(II) on alumina. The adsorption results were analyzed by the Langmuir adsorption isotherm over a wide range of Co(II) concentration (10^{-6} to 10^{-3} m). The adsorption of Co(II) was an endothermic process and increased markedly with temperature between 30 and 100°C. The heat of adsorption decreased with increasing surface coverage of the oxides. At saturation coverage, the heats of adsorption for Co(II) on Al_2O_3, MnO_2, and Fe_3O_4 were –14.9, –14.3, and –6.3 kcal/mol, respectively. Hydrolysis of Co(II) is suggested as a possible mechanism for the marked dependence of adsorption on pH and temperature. (auth) (Canada)

47745 EVALUATION OF UNBONDED O–H GROUPS FOR HDO IN LIQUID D_2O FROM INFRARED ABSORPTIVITY MEASUREMENTS. Clarke, E. C. W.; Glew, D. N. (Dow Chemical of Canada, Sarnia). Can. J. Chem.; 50: No. 11, 1655-65(1 Jun 1972).

Wyss and Falk's infrared absorptivities between 10 and 85°C for HDO in liquid D_2O in the fundamental O—H stretch region were analyzed numerically and showed a statistically significant weak band near 3600 cm^{-1} at each temperature. This band, the Raman analog of which was reported earlier, confirms the presence of HDO species with unbonded O—H groups in the liquid state. The percentage of HDO species with unbonded O—H groups is 4.6, 6.1, 10.1, and 11.9, respectively, at 10, 35, 60, and 85°C. The four predominant HDO species in equilibrium at low temperatures are defined together with their equilibrium constant for the O—H---O bond-rupturing process. A standard enthalpy change of $\Delta H° = 6800 \pm 1100$ cal was found for the rupture of one mole of O—H---O bonds. This is in contrast with the apparent enthalpy change of 2900 ± 500 cal, as usually derived from the temperature dependence of the equilibrium quotient. Approximate mole fractions for each of twelve differently bonded HDO species were derived from a model for random H- and D-bond statistics. Results show that the four predominant HDO species give a full interpretation of the absorptivities at 10, 35, and 60°C but that additional minor species contribute slightly to the absorptivity at 85°C. (auth) (Canada)

Isotope Effects

Refer also to abstracts 47771, 47781, 47819, and 47858.

47746 DIMERIZATION AND ISOTOPIC MIXING OF ETHYLENE BY A PALLADIUM COMPLEX CATALYST. Kitamura, Taketsugu; Maruya, Ken-ichi; Moro-oka, Yoshihiko; Ozaki, Atsumu (Tokyo Inst. of Tech.). Bull Chem. Soc. Jap.; 45: 1457-60(1972).

Dimerization and accompanied isotopic exchange of ethylene were studied with dichlorobis(benzonitrile)palladium(II) complex in benzene solution. Dimerization as well as isotopic exchange take place simultaneously after an induction period, the extent of which is reduced by the presence of hydrogen releasing olefin such as 3-methyl-1-butene. Kinetics of dimerization is of first order in ethylene, but the dimerization rate does not immediately respond to the change in ethylene pressure. The results are interpreted in terms of a preformed palladium hydride complex. (auth)

47747 HALF-QUENCHING PRESSURES IN THE ASSOCIATION OF METHYL RADICALS-d_0 AND -d_3. Kobrinsky, O. C.; Pritchard, G. O. (Univ. of California, Santa Barbara). J. Phys. Chem.; 76: No. 16, 2196-8(3 Aug 1972).

Cross-combination studies were reported for CF_3 and CH_3 (or CD_3) radicals to determine the half-quenching pressures, $P_{1/2}$, when the decomposition rate equals the collisional stabilization rate for $C_2H_6^*$ and C_2D_6. The results were not consistent and appeared to depend on the nature of the photolytic source molecules. CF_3COCH_3 and $CF_3N_2CH_3$ were used to produce $C_2H_6^*$, and $P_{1/2}$ values differing by a factor of 10 were obtained at 25 and 120°C. An isotope effect of about 10 was indicated for $C_2D_6^*$ decomposition vs. C_2H_6 decomposition at 25 and 120°C, using ketones as photolytic radical sources. (auth)

47748 INFRARED SPECTRA OF ADDITION COMPOUNDS OF HYDROGEN AND DEUTERIUM CYANIDES WITH BORON TRIBROMIDE. Kanesaka, Isao; Hase, Yoshiyuki; Kawai, Kiyoyasu (Toyama Univ., Japan). Bull. Chem. Soc. Jap.; 45: No. 6, 1595-8(Jun 1972).

The infrared spectra of addition compounds of hydrogen and deuterium cyanides with boron tribromide were measured in the frequency region from 4000 to 200 cm^{-1}, and the normal frequencies are proposed on the basis of the C_{3v} symmetry for four isotopic compounds, $HCN \cdot {}^{10}BBr_3$, $HCN \cdot {}^{11}BBr_3$, $DCN \cdot {}^{10}BBr_3$, and $DCN \cdot {}^{11}BBr_3$. The force constants were calculated on the assumption of a modified Urey–Bradley force field, and the shift of the vibrational frequencies by the coordination has been discussed. (auth)

47749 TRANSITION STATE GEOMETRY IN HYDROPEROXIDATION OF MONOOLEFINS WITH SINGLET OXYGEN. Nickon, A.; Chuang, V. T.; Daniels, P. J. L.; (and others) (Johns Hopkins Univ., Baltimore). J. Amer. Chem. Soc.; 94: No. 15, 5517-18 (26 Jul 1972).

Stereochemical and isotope effect evidence that the transition state in the hydroperoxidation of monoolefins with singlet oxygen resembles the starting olefin and that there is no strong inherent preference for creation of an axial type C–O bond over an equatorial type. In the oxygenation of 2,3-dimethyl-2-butene (CH_3-$(CH_3)CC(CD_3)CD_3$ and $CH_3(CD_3)CC(CD_3)CH_3$) and bicyclohexylidene the competition between H and D abstraction is intramolecular and mass spectral d_6/d_5 ratios of derived alcohols provide k_H/k_D. Results show consistently low, positive k_H/k_D values under a variety of experimental conditions. (D.H.M.)

47750 UNUSUALLY LARGE CONFORMATIONAL KINETIC ISOTOPE EFFECT IN [2.2]METAPARACYCLOPHANE. Sherrod, S. A.; Boekelheide, V. (Univ. of Oregon, Eugene). J. Amer. Chem. Soc.; 94: No. 15, 5513-15(26 Jul 1972).

The steric factor in conformational kinetic isotope effect was studied using 8-deuterio[2.2]metaparacyclophane. From longitudinal relaxation times and ring flipping rates the isotope effect was found to be $k_D/k_H = 1.20 \pm 0.04$ ($\Delta\Delta F^\ddagger = 112$ cal/mol). (D.H.M.)

47751 DEPENDENCE OF MECHANISM ON pH FOR DEUTERIUM–HYDROGEN EXCHANGE IN 1-METHYLTETRAZOLE-5-d. TRANSITION METAL ION CATALYSIS OF A DEPROTONATION PROCESS. Kohn, Harold; Benkovic, Stephen J.; Olofson, R. A. (Pennsylvania State Univ., University Park). J. Amer. Chem. Soc.; 94: No. 16, 5759-65(9 Aug 1972).

The pH-rate profile of protium for deuterium exchange of 1-methyltetrazole-5-d in aqueous solution at 67.6° was determined and used as a control experiment in a demonstration that σ complexation of a heteroaromatic substrate with a transition metal cation (Cu^{2+} and Zn^{2+} used) can have a major rate-enhancing effect on processes in which substrate ring substituents are eliminated to produce formal sp^2 carbanion intermediates. The control experiment is itself of interest, since in addition to a flattened exchange rate minimum at pH 4, a rate maximum is found at $-H_0$ 1 to 1.5, well below the experimental H_0 (ca. -2.4) for half-protonation of 1-methyltetrazole. (auth)

47752 POTENTIAL CONSTANTS OF IRON PENTACARBONYL FROM VIBRATIONAL SPECTRA OF ISOTOPIC SPECIES. Jones, Llewellyn H.; McDowell, Robin S.; Goldblatt, Maxwell; Swanson, Basil I. (Los Alamos Scientific Lab., N. Mex.). J. Chem. Phys.; 57: No. 5, 2050-64(1 Sep 1972).

The vibrational spectra of $Fe(^{12}C^{16}O)_5$, $Fe(^{13}C^{16}O)_5$, and $Fe(^{12}C^{18}O)_5$ were observed. Most of the fundamentals were assigned, with some changes from earlier results in the literature. Potential constants were calculated by constraining many of the interaction constants to values estimated from analogous constants of the hexacarbonyls. The results indicate that the axial CO bonds are stronger than the equatorial CO bonds. This implies that the axial MC bonds are weaker than the equatorial MC bonds, though the calculated MC potential constants are not significantly different. (auth)

47753 COMPARISON OF ISOTOPE SHIFTS IN THE VIBRATIONAL SPECTRUM OF GAS-PHASE AND MATRIX-ISOLATED HYDROGEN CYANIDE. Gabelnick, S. D. (Argonne National Lab., Ill.). J. Phys. Chem.; 76: No. 17, 2483-4(17 Aug 1972).

Results of a study of $H^{12}C^{14}N$, $H^{13}C^{14}N$, $H^{12}C^{15}N$, $D^{12}C^{14}N$, $D^{13}C^{14}N$, and $D^{12}C^{15}N$ showed that no anomalies exist between the matrix and gas-phase data when the uncertainties in the measurements and the sensitivity of the bond-length ratio to these uncertainties are properly taken into account. (D.H.M.)

47754 IR-SPECTRA OF THE PENTACYANONITROSYL COMPLEXES OF TRANSITION METALS. II. Ziolkowski, J.; Jezowska-Trzebiatowska, B.; Kedzia, B. B. (Univ., Wroclaw. Technical Univ., Wroclaw). Bull. Acad. Pol. Sci., Ser. Sci. Chim.; 20: No. 3, 231-6(1972).

Infrared spectra of a number of the pentacyanonitrosyl complexes of the $[M(CN)_5NO]^{-n}$ type (M = V, Cr, Mo, Mn, Fe, Ru) were studied in the range of 4000 to 200 cm^{-1}. The assignments of fundamental vibrations were completed by the study of the ir spectra of the isotopic species $Na_2[Fe(CN)_5{}^{15}NO] \cdot 2H_2O$, $Na_2[Fe(CN)_5NO] \cdot 2D_2O_9$ and $Na_2[Fe(CN)_5NO] \cdot 2(HD)_2O$. (auth)

47755 REACTIONS OF AROMATIC RADICAL ANIONS. VII. KINETIC STUDY OF THE REACTION OF SODIUM ANTHRACENE WITH WATER. Bank, Shelton; Bockrath, Bradley (State Univ. of New York, Albany). J. Amer. Chem. Soc.; 94: No. 17, 6076-83(23 Aug 1972).

The kinetics of the reaction of sodium anthracene with water was studied. The rate law is $-d[Anth\cdot^-]/dt = 2k_1[Anth\cdot^-][H_2O]$, with a value of k_1 at 20° of 664 M^{-1} sec^{-1} in tetrahydrofuran. The dihydroanthracenyl anion intermediate is more reactive than the radical anion. Activation parameters, the deuterium kinetic isotope effect, and the effect of ion pairing are included in the study. The mechanisms of protonation of sodium anthracene and sodium naphthalene are directly analogous; however, contrary to molecular orbital localization energy calculations, sodium anthracene is considerably less reactive than sodium naphthalene. The state of ion pairing of the radical anion has a marked effect upon reactivity. Finally, water bound to solvent-separated or free sodium ion is postulated to be the kinetically active proton donor. The discussion includes comparison of this system with other related work. (auth)

47756 MEASUREMENT OF THE KINETICS AND ACTIVATION PARAMETERS FOR THE HYDROBORATION OF TETRAMETHYLETHYLENE AND MEASUREMENT OF ISOTOPE EFFECTS IN THE HYDROBORATION OF ALKENES. Pasto, D. J.; Lepeska, B.; Cheng, T.-C. (Univ. of Notre Dame, Ind.). J. Amer. Chem. Soc.; 94: No. 17, 6083-90(23 Aug 1972).

The kinetics of the hydroboration of tetramethylethylene (TME) with borane in tetrahydrofuran (THF) were studied. The rate of formation of 2,3-dimethyl-2-butylborane is found to be first order in both borane and TME. The activation energy and entropy for the reaction are 9.2 ± 0.4 kcal/mol and -27 ± 1 eu. The hydrogen–deuterium kinetic isotope effect is found to be 1.18. The reaction is considered to involve the direct reaction between a molecule of the borane–THF complex and alkene in a very early transition state. The $^1H/^3H$ isotope effects in the hydroboration of various alkenes with borane and selected mono- and dialkylboranes were measured. The k_{1H}/k_{3H} decreases markedly as the degree of substitution on the double bond increases: monosubstituted alkenes, 10.0–11.3 (calculated on the basis of no hydrogen exchange between borane species); disubstituted alkenes, 8.7–9.0; trisubstituted alkenes, 4.2–4.3; and TME, ~3.3. Similarly k_{1H}/k_{3H} decreases as the degree of substitution on boron increases. The k_{10B}/k_{11B} isotope effect in the hydroboration of various substituted alkenes with borane increases only slightly with increasing substitution on the double bond (1.03 to 1.05). (auth)

47757 POLAR ELECTROPHILIC ADDITIONS TO STYRENE. SECONDARY DEUTERIUM ISOTOPE EFFECTS. Wilkins, Charles L.; Regulski, Thomas W. (Univ. of Nebraska, Lincoln). J. Amer. Chem. Soc.; 94: No. 17, 6016-20(23 Aug 1972).

α-Secondary deuterium isotope effects for polar additions of electrophiles to styrene, trans-1-phenylpropene, p-bromo-, p-chloro-, and p-nitrostyrene were measured. The reactions were carried out at 40°C in dry acetic acid using bromine, chlorine, and 2,4-dinitrobenzenesulfenyl halides as the electrophiles. Very small isotope effects ($k_H/k_D = 0.97$ to 1.00) were found for bromine and chlorine additions to all but p-nitrostyrene. In that case, k_H/k_D values of 0.95 and 0.96, respectively, were found. For the additions of 2,4-dinitrobenzenesulfenyl halides, k_H/k_D values in the range of 0.94 to 0.97 were found for all the styrenes examined. These results are interpreted with the help of stereochemical and kinetic data. (auth)

47758 QUATERMOLECULAR PROTON TRANSFER OF 2,4-LUTIDINE AND ITS CONJUGATE ACID IN AQUEOUS SOLUTION. Rosenthal, Donald; Grunwald, Ernest (Brandeis Univ., Waltham, Mass.). J. Amer. Chem. Soc.; 94: No. 17, 5956-61(23 Aug 1972).

Symmetrical proton exchange between 2,4-lutidine and its conjugate acid in aqueous solution proceeds with participation of (on the average) 1.74 water molecules in H_2O and 1.8 water molecules in $HOD-D_2O$ (5 at. % H). Within the experimental error both processes could be precisely quatermolecular; second-order rate constants at 25° are 1.05×10^8 sec^{-1} M^{-1} in H_2O and 0.26×10^8 sec^{-1} M^{-1} in $HOD-D_2O$. The high values of these rate constants, in spite of the quatermolecular nature of the reaction, indicate strong hydrogen-bonded solvation of at least one of the reactant solutes. The mechanism of acid dissociation of 2,4-lutidinium ion has been reexamined on the basis of kinetic $HOD-D_2O$ solvent isotope effects and salt effects. The initial product of acid dissociation may be a lutidine molecule that is not hydrogen bonded to a water molecule at the nitrogen atom. (auth)

Isotope Exchange and Isotope Separation

Refer also to abstracts 47857 and 47874.

47759 (COO-3105-3) TRITIATION BY MICROWAVE DISCHARGE ACTIVATION OF TRITIUM GAS: A STUDY OF MECHANISM AND ITS APPLICATION TO THE LABELING OF ADRENOCORTICOTROPIC HORMONE (ACTH). Ehrenkaufer, Richard; Wolf, A. P. (Brookhaven National Lab., Upton, N. Y.); Lieberman, Seymour; Hembree, Wylie; Zimmering, Paula (Columbia Univ., New York. Coll. of Physicians and Surgeons). 1972. 12p. (CONF-710809–17). Dep. NTIS.

From Tritium symposium; Las Vegas, Nev. (30 Aug 1971).

A method of general tritium exchange was developed using microwave discharge activation of tritium gas, which is reproducible, reliable, inexpensive, and applicable to most classes of organic compounds. The production of tritium-labeled adrenocorticotropic hormone with a specific activity nearly 2000 times greater than previously available, with full biological activity is described. The investigation of some parameters of the labeling process in order to maximize the tritium-hydrogen exchange for further application to biologically important compounds is also discussed. (auth)

47760 (JAERI-Memo-3961) SEPARATION OF URANIUM ISOTOPES BY CHEMICAL EXCHANGE. (Japan Atomic Energy

Research Inst., Tokyo). Jan 1970. (In Japanese). NTIS (U. S. Sales Only).

Experimental results on uranium isotope separation by a chemical exchange method are reviewed. The chromatographic technique and countercurrent operation were used to multiply an isotope effect between the uranous and uranyl ions. The apparent process of the isotope exchange under study is represented as $[^{235}U(IV)_{complex}]_{resin} + [^{238}U(VI(O_2^{2+}]_{solution} \rightleftharpoons [^{238}U(IV)_{complex}]_{resin} + [^{235}U(VI)O_2^{2+}]_{solution}$. The heavy uranium isotopes are concentrated preferentially in the U(IV) complex ions and the equilibrium constant, K is about 1.0005, independently of the experimental condition. The statistical quantum theory for isotopic equilibrium constant and experiments on the shift of wave number in a uranium compound due to the change of isotope are presented. The isotope exchange rate process and its mechanism are discussed. The separation of uranium isotopes by chromatographic techniques and their kinetic theory are considered. (auth)

47761 $[3,4\text{-}D_2]$THIOPHEN: SYNTHESIS AND SCRAMBLING ON ELECTRON IMPACT. Dawson, R. M.; Gillis, R. G. (Australian Defence Scientific Service, Ascot Vale). Aust. J. Chem.; 25: No. 6, 1221-7(Jun 1972).

$[3,4\text{-}D_2]$Thiophen (1) was prepared by hydrogen-deuterium exchange reactions using trifluoroacetic acid. $[2,5\text{-}D_2]$Thiophen (2) and (1) show an unexplained difference in the amount of scrambling in the formation of the CHS^+ ion on electron impact. This difference is maintained when the electron beam and ion drawout voltages are varied. (auth)

47762 EFFECT OF POSITION OF SUBSTITUTION ON THE SEPARATION BEHAVIOR OF DEUTERATED TOLUENE. Macnaughtan, Donald Jr.; Rogers, L. B. (Purdue Univ., Lafayette, Ind.). Contract AT(11-1)-1222. Separ. Sci.; 7: No. 4, 307-18 (1972).

The position and number of deuterium atoms substituted onto the toluene molecule was found to affect its separation behavior on a silver nitrate-water column. Substitution on the ring affected the capacity ratio substantially while substitution on the methyl group had no measurable effect. At the same time, the separation behaviors of benzene and perdeuterobenzene were examined using several other salt solutions and polar liquids as possible stationary phases. (auth)

47763 COMPETITIVE PROCESSES FOR ISOTOPIC SEPARATION IN THE SOLID PHASE. LoData, Vincent A. (Simulating Science and Engineering, Wappingers Falls, N. Y.). Separ. Sci.; 7: No. 4, 319-29(1972).

The kinetic scheme for the photo-isotopic separation of uranium is discussed. The effect of different processes on the efficiency is demonstrated and it is shown that the addition of a quencher enhances the selectivity but decreases the efficiency of the process. (auth)

47764 HETEROGENEOUS ISOTOPIC EXCHANGE BETWEEN IODINE ADSORBED ON PLATINUM AND IODIDE, IODINE, AND TRIIODIDE. Toth, G. Radiochim. Acta; 17: No. 1, 12-17(May 1972).

The fraction exchange (1−F) varies in the case of heterogeneous isotopic exchange taking place between iodine adsorbed on platinum and I^-, I_2, or I_3^- according to an equation derived from the McKay equation, taking into account the energetic nonuniformity of the platinum surface by replacing the velocity constant in the McKay equation by a time dependent velocity coefficient. There exists a good agreement between experimental data and the equation at least for a period of a few thousand minutes. The rate of the isotopic exchange is in the case of I_3^- the highest and in the case of I^- the lowest. The higher the concentration of the iodine species involved in the exchange process the greater the corresponding slope. (M.C.G.)

47765 MECHANISM OF ISOTOPIC EXCHANGE IN A HETEROGENEOUS SYSTEM. Rahman, M. K.; Barrett, J. (Chelsea Coll. of Science and Tech., London). J. Chromatogr.; 69: No. 2, 261-72(5 Jul 1972).

Using the ^{32}P isotope, the exchange of phosphate ions between zirconium phosphate and aqueous solution was investigated. The exchange proceeds through two measurable processes whose rates differ by a factor of about ten, followed by an extremely slow third process. Of the two measurable processes, the faster one involves the phosphate groups at the surface of the solid while the other can be assigned to the interior phosphate groups. The mechanism of the surface process involves the hydrolysis of the phosphate groups at the surface followed by exchange between the phosphate groups and the hydrolyzed material. The mechanism of the second process assigned to the interior phosphate groups involves the same chemistry as the surface reaction, the process being slower owing to the slower rate at which the aqueous phase comes into contact with the internal phosphate groups. (auth)

47766 CALCULATION OF SOME ISOTOPE SEPARATION FACTORS FOR CHEMICAL EXCHANGE, DISTILLATION, EXCHANGE DISTILLATION, AND ABSORPTION USING $UF_{6(g)}$. Bigeleisen, J. (Univ. of Rochester, N. Y.). J. Inorg. Nucl. Chem.; 34: No. 8, 2505-11(Aug 1972).

The reduced partition function of $(^{238}UF_6/^{235}UF_6)_g$ was calculated from the vibrational potential function of Claassen (J. Chem. Phys. 30, 968 (1959)) in good agreement with a previous calculation by Mayer and Bigeleisen (J. Chem. Phys. 15, 261 (1947)). Implications of this calculation with respect to chemical exchange reactions of $UF_{6(g)}$ with complexes of UF_6 are discussed. The quantum mechanical theorem of corresponding states and the vibrational spectra of $UF_{6(g)}$, $UF_{6(1)}$, and UF_6 dissolved in C_7F_{16} were used to calculate $\ln(f_c/f_g)$ in the liquid and solution. These led to $\ln\alpha$ values for distillation and absorption of -4×10^{-5} and $+6 \times 10^{-6}$, respectively. $^{238}UF_6$ was calculated to be more volatile than $^{235}UF_6$ in agreement with experiment. The feasibility of separation of uranium isotopes by exchange chromatography is discussed. (auth)

Feed Materials Processing

Refer also to abstract 48025.

47767 (RISO–253) CHEMISTRY AND KINETICS OF THE SULPHATING ROASTING OF URANIUM-BEARING SILICATES. Asmund, G. (Danish Atomic Energy Commission, Risoe. Research Establishment). Oct 1971. 125p. Dep. NTIS (U. S. Sales Only).

Sulfating roasting is a process where a gas containing SO_2 or SO_3 reacts with a solid, producing sulfates. Uranium from the Kvanefjeld in South Greenland can be solubilized by that process. Models for the reaction with the most important constituting minerals are suggested and tested experimentally. For the mineral steenstrupine the model is new. The solid component, which is metal and oxygen ions, is transported from the original position in the crystal lattice to the surface, where it reacts with the gas. The transportation rate for constant sulfating conditions is proportional to the number of open micropores and to the amount of unreacted solid component. During the reaction the pores are blocked, and thus lose their ability to act as a transportation path for the solid component. The blocking rate is expressed by the equation $dN = a\ R\ N\ dx$, where N is the number of open pores in a grain, R is the grain size, and x is the fractional conversion. The kinetic model for monazite- and aegirine sulfation is identical with the steenstrupine model except for the assumption that the transportation rate is independent of the amount of unreacted solid. In the arfvedsonite sulfation part of the outward migration of metal ions is balanced by the simultaneous oxidation of Fe^{2+} to Fe^{3+}. The rest of the reaction is controlled by the diffusion of the large oxygen ion. Sulfation of the crushed lujavrite ore follows a logarithmic law. It was not possible to find any other mineral with the same high affinity to sulfation as arfvedsonite, steenstrupine, and monazite from the Kvanefjeld. A new concept, "Chemical radius" defined as (2.59/electronegativity), is used together with ionic radius to explain the percentage of metal yield when a multi-metal mineral is sulfated. (auth)

47768 SEPARATION OF VANADIUM FLUORIDES FROM UF_6 CONTAINING GAS STREAMS. Kuhrt, Winfried; Kreutz, Rolf; Schindler, Hubert; Massonne, Joachim (Kali-Chemie AG, Hanover). Z. Naturforsch.; 27b: No. 7, 748-52(Jul 1972). (In German).

The preparation of surface active MgF_2, CaF_2, AlF_3, BiF_3 in the shape of pellets is described. The testing of the adsorptive capacity of these pellets as well as of NaF pellets of the commercial qualities at temperatures in the range from 60 to 400°C showed that sodium fluoride seems to be the most efficient adsorbent for the purification of UF_6 containing gas streams from small quantities of VOF_3 and VF_5 at 250 to 300°C, a problem occurring at the conversion of uranium. For short-time separations of $UF_6/VOF_3/VF_5$ or of UF_6/VOF_3 the use of MgF_2 at about 300°C, or AlF_3 at 100 to 200°C, may be taken into consideration. (auth)

47769 MINING AND PROCESSING OF URANIUM ORE. Siegers, A. (Urangesellschaft mbH and Co. KG, Frankfurt am Main). Kerntechnik; 14: No. 6, 254-60(Jun 1972). (In German and English).

Raw uranium ore as mined has a very low uranium content and must therefore be up-graded in an ore processing plant. This processing does not affect the isotopic composition of the uranium. The final processed product is called yellow cake and contains about 70% uranium in the form of uranium compounds. (auth)

Radiation Chemistry

Refer also to abstracts 47654, 47887, 48118, 49306, and 50022.

47770 (BNWL–1664) RADIOLYSIS OF HELIUM DILUTED MIXTURES OF CARBON MONOXIDE AND WATER VAPOR. Turcotte, R. P.; Tingey, G. L. (Battelle Pacific Northwest Labs., Richland, Wash.). Jun 1972. Contract AT(45-1)-1830. 24p. Dep. NTIS.

Product yields for the radiolysis regularly decrease for $[CO] = [H_2O] < 10^4$ vpm, but are constant at $G_{H_2} = 6.0$ and $G_{CO_2} = 8.5$ for all higher concentrations. At high dilution (<100 vpm), a stoichiometric ratio of products is obtained such that $G_{H_2} = G_{CO_2} = 0.012\,[x]$ for $[x] = [H_2O] = [CO]$. Product yields decrease with increasing temperature such that $\Delta G/\Delta T \sim 1/500$, where G is molecules/100 eV and T is °C. This suggests that the activation energy is negative as obtained by the treatment employed. The absolute value of activation energy is a function of the treatment used but regardless of the approach, the values decrease with increasing dilution. A thermally unstable oxygen-containing product (probably C_3O_2) and CH_4 were observed as significant products in addition to CO_2 and H_2. (auth)

47771 (COO–1116-20(Pt.2)) KINETIC ISOTOPE EFFECTS IN THE RADIOLYSIS OF WATER VAPOR AND IN THE REACTIONS OF HYDROGEN ATOMS WITH WATER VAPOR. Technical Progress Report, Part IIA, September 1, 1971–July 23, 1972. Firestone, Richard F. (Ohio State Univ. Research Foundation, Columbus). 23 Jul 1972. Contract AT(11-1)-1116. 19p. Dep. NTIS.

Studies on kinetic isotope effects on the rate constants of reactions of H atoms with H_2O molecules in the gaseous phase are reported. Samples of $H_2O-TOH-D_2$ and $D_2O-TOD-H_2$ were irradiated with tritium beta particles at 84° to 381°C. H/T and D/T kinetic isotope separation factors for the radioinduced exchange are tabulated. Hydrogen isotope effects on the radiolytic yield of hydrogen atoms were studied. Relative values of rate constants were calculated for reactions of H and D atoms with light, heavy, and partially tritiated light and heavy water molecules. Absolute values of Arrhenius parameters for reactions of H atoms with heavy water molecules are reported. (J.G.B.)

47772 (COO–1116-20(Pt.3)) EFFECTS OF DOSE AND INITIAL PROPANE CONCENTRATION IN THE TRITIUM BETA-RAY INDUCED DECOMPOSITION OF DOD VAPOR IN THE PRESENCE OF C_3H_8. Technical Progress Report, Part IIB, September 1, 1971–July 23, 1972. Firestone, Richard F. (Ohio State Univ. Research Foundation, Columbus). 23 Jul 1972. Contract AT(11-1)-1116. 21p. Dep. NTIS.

The 100-eV yield of HD in self-irradiated DOD-TOD-C_3H_8 mixtures was determined. It was demonstrated that G(HD) is a function of dose and of initial C_3H_8 concentration, tending to decrease with increasing percent conversion of C_3H_8 from an extrapolated zero dose value of 7.8 ± 0.2 molec./100 eV. The distribution of organic products and of tritium among them was inconsistent with the simple scavenger mechanism commonly assumed. (M.C.G.)

47773 (COO–1116-20(Pt.4)) OPTICAL ABSORPTION SPECTRA AND DECAY OF SOLVATED ELECTRONS IN THE PULSE RADIOLYSIS OF DILUTE SOLUTIONS OF ETHANOL IN ALKANE SOLVENTS. EFFECTS OF HYDROCARBON CHAIN BRANCHING. Technical Progress Report, Part IV, September 1, 1971–July 26, 1972. Firestone, Richard F. (Ohio State Univ. Research Foundation, Columbus). 26 Jul 1972. Contract AT(11-1)-1116. 8p. Dep. NTIS.

The absorption spectrum of the solvated electron in solutions of ethanol in 3-methylpentane, 2,2-dimethylbutane, and neopentane is, above a few mole percent of ethanol, essentially independent of the presence of hydrocarbon at room temperature. Above 20 mole % solvated electron yields per unit of dose increase in the same order as radiolytic free-ion yields in the pure hydrocarbons. Below 10 mole % progressively greater concentrations of ethanol are required for observation of a given initial solvated electron yield in reverse of this order, and the half-time for decay of the solvated electron decreases in the same order at a given ethanol concentration. These observations are discussed briefly in the context of preferential solvation of free electrons by microscopic aggregates of ethanol molecules. (auth)

47774 (COO–2147-1) RADIATION GRAFTING OF SYNTHETIC HYDROGELS TO INERT POLYMER SURFACES. I. HYDROXYETHYL METHACRYLATE. Lee, H. B.; Shim, H. S.; Andrade, J. D. (Utah Univ., Salt Lake City. Div. of Materials Science and Engineering). 1972. Contract AT(11-1)-2147. 11p. (CONF-720821-2). Dep. NTIS.

From 164th National American Chemical Society Meeting; New York, NY. (27 Aug 1972).

Hydroxyethyl methacrylate (HEMA) was radiation-grafted to polypropylene and poly(dimethylsiloxane) substrates using the mutual irradiation technique and a ^{60}Co source. HEMA concentrations of 0, 5, 10, 15, and 20% in 95% ethanol were utilized. Dry graft weights were determined. The fraction of water in the graft was also determined. The graft weight increased linearily with dose to a maximum; further increase in dose then resulted in graft degradation. The water swelling is explained in terms of graft morphology, as determined by scanning electron microscopic examination. The potential usefulness of aqueous gel surfaces for biomedical application is discussed. (auth)

47775 (JAERI-M–4631) PRELIMINARY INVESTIGATIONS ON THE USE OF ADSORBENT POLYETHYLENE FORMED BY RADIATION-INDUCED POLYMERIZATION. Okada, Minoru; Takehisa, Masaaki; Danno, Akibumi; Machi, Sueo; Makuuchi, Keizo (Japan Atomic Energy Research Inst., Tokyo). Dec 1971. 11p. (In Japanese). NTIS (U. S. Sales Only).

Polyethylene powder or porous polyethylene, polymerized by radiation, has a considerably large specific surface area. To find its use, research work was done on the following items: (1) the direct preparation of porous filters by radiation-induced polymerization of ethylene, (2) the application of polyethylene as produced by radiation-induced polymerization to packing material for gas chromatography, (3) the direct fluorination of polyethylene powder, and (4) thermal behavior of fluorinated polyethylene powder. (auth)

47776 (JAERI-Memo–4049) DIRECT PREPARATION OF POROUS POLYETHYLENE FILTERS BY RADIATION POLYMERIZATION OF ETHYLENE. Okada, Minoru; Takehisa, Masaaki; Machi, Sueo; Danno, Akibumi (Japan Atomic Energy Research Inst., Tokyo). Oct 1969. (In Japanese). NTIS (U. S. Sales Only).

Ethylene was polymerized directly by gamma radiation in glass tubes to prepare porous filters, which seemed to be macroscopically homogeneous. The effect of the bulk density on "treatment capacity" was observed, air samples containing 0.1 wt.% iodine vapor were let pass through the filter. Treatment capacity is defined as that amount of air per gram of PE that is passed through a filter until the polyethylene reaches the break point. The treatment capacity is approximately constant at 9×10^2 cm^3/g over the bulk density range from 0.03 to 0.07 g/cm^3, and it is lower outside of this range. The higher the bulk density, the higher the pressure drop in the filters. Because of both the necessity of high treatment capacity and of low pressure drop, the optimum bulk density of PE in the filter is about 0.03 g/cm^3. (auth)

47777 (ORO–3106-45) RADIATION CHEMISTRY OF HYDROCARBON AND ALKYL HALIDE SYSTEMS. Progress Report, August 1, 1971–July 31, 1972. Hanrahan, Robert J. (Florida Univ., Gainesville). 1972. Contract AT(40-1)-3106. 17p. Dep. NTIS.

Mass spectrometric studies on products of the gas-phase γ radiolysis of $C_2F_6-C_2H_6$ are reported. Yields from the γ and x radiolysis of bromoethane were also studied. Investigation of the rare-gas-sensitized decomposition of fluorocarbon compounds in a flow-discharge system was continued. Studies on the gas phase radiolysis of hexafluorocyclobutene are reported. (J.G.B.)

47778 (PEL–218) RADIATION-INDUCED IONIC POLYMERIZATION OF ISO-BUTYL VINYL ETHER IN BULK AND IN SOLUTION. du Plessis, T. A. (Atomic Energy Board, Pelindaba, Pretoria (South Africa)). Aug 1971. 31p. Dep. NTIS (U. S. Sales Only).

The radioinduced ionic polymerization of iso-butyl vinyl ether was investigated under conditions where the monomer was dried with molecular sieves. The investigation covered some aspects of the drying technique, the temperature range from −16 to 90°C, the dose rate range from 10^{15} to 10^{20} eV g^{-1} sec^{-1} by using both gamma rays and electrons, and the influence of methylene chloride and diethyl ether as solvents for the monomer. The monomer and its solutions could be dried to very high levels of dryness by using molecular sieves as a drying agent. For both the bulk monomer and its solution in diethyl ether a very high overall activation energy was found, which decreased above 30°C. No such change was found for the solution in methylene chloride. Above 30°C, however, the value of the overall activation energy for both the bulk monomer and its solution in methylene chloride has a value of 5.5 ± 0.5 kcal $mole^{-1}$. The dose rate dependence of the rate of polymerization was found to be 10.58 over the entire dose rate range investigated for the bulk monomer. The corresponding values for the solutions of the monomer were found to be unity. The molecular weight of the polymer was found to be far less sensitive to trace amounts of water than the rate of polymerization. The molecular weight of the polymer depended strongly on the irradiation temperature, reaching a maximum value of about 130,000 at 35°C. This same effect was found for polymers obtained from the monomer solutions, although the molecular weights were much lower. For both the bulk monomer and its solution in diethyl ether, regenerative chain transfer plays an important role in determining the molecular weight of the polymer. For the solution in methylene chloride, however, chain transfer appears to be less important. (auth)

47779 (UCRL-51222) IRRADIATION OF A POLY-M-CARBORANYL SILOXANE AND SOME RELATED COMPOUNDS. Cunningham, Stephen S.; Maimoni, Arturo (California Univ., Livermore. Lawrence Livermore Lab.). 4 May 1972. Contract W-7405-eng-48. 12p. Dep. NTIS.

The number of gas molecules evolved for 100 eV of adsorbed dose (G-value) was obtained for the neutron and ^{60}Co γ-irradiation of a poly-m-carboranyl siloxane formulation, and for the neutron irradiation of o-carborane and isopropyl o-carborane. A poly-dimethyl siloxane rubber was also irradiated. The carborane moiety adds stability to the silicone chain and to the aliphatic chain; however, it is not as effective in this respect as the aromatic ring. The G-values are: poly-m-carboranyl siloxane, 0.93; poly-dimethyl siloxane, 2.4; o-carborane, 1.09; and isopropyl o-carborane, 1.37. The latter value can be compared with the corresponding G-values for benzene, 0.06; isopropyl benzene, 0.245, and poly-ethylene, 2 to 5. Some heating experiments were also performed on irradiated and un-irradiated poly-m-carboranyl siloxane. (auth)

47780 (UR-3490-125) ELECTRON SPIN RESONANCE STUDIES OF γ-IRRADIATED DINUCLEOTIDES AND RELATED COMPOUNDS AT 77°K. Bernhard, W. A.; Danyluk, S. S. (Argonne National Lab., Ill. Rochester Univ., N. Y. Dept. of Radiation Biology and Biophysics). 1972. 28p. Dep. NTIS.

Polycrystalline samples of 19 dinucleotides, barium diethyl phosphate, and 3′-cytidylic acid were γ-irradiated and observed at 77°K by electron spin resonance. In 18 of the dinucleotides and barium diethyl phosphate a doublet having a hyperfine splitting of 117 to 124 Gauss and g-value (spectroscopic splitting factor) of 1.998 to 2.000 was observed. It was concluded that the doublet hyperfine interaction is due to ^{31}P. The free radical postulated to account for the observed doublet is (RO) (R′O) PO_2, with the unpaired electron localized on one or both of the non-ester oxygens. A similar radical, (HO) (RO) PO_2, is the postulated assignment for the observed 145 Gauss hyperfine doublet observed in 3′-cytidylic acid. Depending on the individual dinucleotide, the free radical giving rise to the 120 Gauss doublet after a dose of ~10 MR accounts for from ~0.1% to ~5% of the total number of free radicals produced. (auth)

47781 APPLICATION OF COMPUTERS TO MO THEORY AND CHEMICAL KINETICS. von Buenau, Guenther (Max-Planck-Institut fuer Kohlenforschung, Muelheim an der Ruhr, Ger.). Angew. Chem. Int. Ed. Engl.; 11: No. 5, 393-402(May 1972).

The nature of the programs available to the experimental chemist and the input data necessary for molecular calculations are discussed. Topics covered include: coordinate calculations, molecular theory, orbital approximation, linear combination methods, semiempirical calculations, examples of application of MO theory, calculation of reaction rate constants, and integration of kinetic equation systems. Application of the BEBO method in calculation of kinetic isotope effects and use of computers for evaluation of data from pulse radiolysis are discussed. (M.C.G.)

47782 RADIOLYSIS OF HYDROGEN CYANIDE IN AN AQUEOUS SYSTEM. III. pH DEPENDENCE OF RADIOLYSIS. Ogura, Hajime; Fujimura, Takashi; Murozono, Sohichi; Hirano, Katsuhiko; Kondo, Masaharu (Tokyo Metropolitan Univ.). J. Nucl. Sci. Technol. (Tokyo); 9: No. 6, 339-43(Jun 1972).

The pH dependence in the radiolysis of deaerated aqueous HCN was investigated. The radiolytic yield of HCN, G(–HCN), decreases to a limiting value of 2.9 in the pH range 1 to 3 while G(–HCN) at pH 5 to 8 is observed to be 5.8. Changes in pH resulted in little effect on the radiolytic yields of ammonia (G = 1.9), formaldehyde (G = 1.1), and carbon dioxide (G = 0.6 to 0.8). The formation of polymeric HCN is inhibited by decreasing the pH. This can be explained as the result of the degradation from the dimeric to the monomeric form by HCN, which is known to be an intermediate compound. From experiments on the effect of adding Cl^- as OH radical scavenger it was concluded that formaldehyde and a part of the ammonia are produced through methylenimine as the intermediate. The radiolysis of aqueous KCN was also studied for making comparison of the radiolysis behavior between cyanide ions and undissociated HCN. (auth)

47783 URETHANE-MODIFIED RADIATION CURABLE PAINT BINDER. Taylor, C. R. (to Ford Motor Co.). Canadian Patent 893,169. 15 Feb 1972.

Ionizing radiation is used to form coated products by in situ polymerization of an unsaturated paint binder. Wood, metal, and synthetic polymers are suitable substrates. The binder may comprise an olefinically unsaturated diurethane formed by reacting one molar part of an organic isocyanate with two molar parts of a hydroxy ester or an alpha-beta olefinically unsaturated carboxylic acid. The ionizing radiation may be an electron beam with average electron energy in the range 100,000 to 500,000 eV. (Canada)

47784 CRITICAL REVIEW OF THE GAS-PHASE REACTION KINETICS OF THE HYDROXYL RADICAL. Wilson, Wm. E. Jr. (Battelle Memorial Inst., Columbus, Ohio). J. Phys. Chem. Ref. Data; 1: No. 2, 535-73(1972).

The literature pertinent to reactions of the hydroxyl radical is reviewed. An extensive discussion is given for reactions of the hydroxyl radical with itself and with CO, H_2, and CH_4. These four reactions are: (1) $OH + OH \rightarrow H_2O + O$; (2) $CO + OH \rightarrow CO_2 + H$; (3) $H_2 + OH \rightarrow H_2O + H$; (4) $CH_4 + OH \rightarrow CH_3 + H_2O$. Values are recommended for k_1 and k_2 and for the ratio k_3/k_2 and k_4/k_2. These rate ratios are used with the previously established value of k_2 to obtain recommended values for k_3 and k_4. The recommended values in $cm^3\ mol^{-1} \cdot s^{-1}$, the temperature range, and the uncertainty are: $k_1 = 1.55 \times 10^{12}$, 300 K, $\log k^{+0.1}_{-0.5}$, $k_2 = 3.1 \times 10^{11} \exp(-300/T)$, 300–2000 K, $\log k \pm 0.3$, $k_3/k_2 = 73 \exp(2300/T)$, 300–2000 K, $\log k_3/k_2 \pm 0.3$, $k_3 = 3.8 \times 10^{13} \exp(-2600/T)$, 300–2000 K, $\log k \pm 0.3$, $k_4/k_2 = 92 \exp(2200/T)$, 300–2000 K, $\log k_3/k_2 \pm 0.3$, $k_4 = 2.85 \times 10^{13} \exp(-2500/T)$, 300–2000 K, $\log k \pm 0.7$. Rate expressions are also recommended for a number of other hydroxyl reactions whose rates are less well established. (auth)

47785 RADIATION-INDUCED POSTPOLYMERIZATION OF TRIOXANE IN THE SOLID STATE. V. STUDIES ON COPOLYMER COMPOSITION. Ishigaki, Isao; Ito, Akihiko; Iwai, Tadashi; Hayashi, Koichiro (Japan Atomic Energy Research Inst., Takasaki). J. Polym. Sci., Part A-1; 10: No. 7, 1883-93(Jul 1972).

Studies on the composition of copolymers obtained by the radiation-induced solid-state postpolymerization of trioxane with 1,3-dioxolane were carried out. Gas-chromatographic analysis of the reaction mixtures showed that most of the 1,3-dioxolane disappears rapidly from the reaction system in an early stage of polymerization, and that the fraction of ethylene oxide units in the copolymer chain [E] decreases markedly with increasing polymer yield. This finding was confirmed by NMR spectra of the copolymer. DSC thermograms of the copolymer indicated that the relationship between the melting point and the average composition of copolymers prepared in this study differed from that found for copolymers in which comonomer units are distributed statistically in the polymer chain. It was suggested that the copolymer formed by the radiation-induced solid-state postpolymerization of trioxane–1,3-dioxolane is characterized by a heterogeneous distribution of ethylene oxide units in the copolymer chain. It was also found that, in the radiation-induced solid-state postpolymerization of trioxane–1,3-dioxolane, the amount of tetraoxane formation increased linearly with increasing polymer yield. Although it is extremely small compared with that obtained in solution polymerization, it is slightly larger in the trioxane–1,3-dioxolane system than in the trioxane system. (auth)

47786 MOLECULAR WEIGHT DISTRIBUTIONS IN RADIATION-INDUCED POLYMERIZATION. VI. γ-RAY-INDUCED POLYMERIZATION OF DRY STYRENE IN THE SOLID STATE. Westlake, John F.; Huang, Robert Y. (Univ. of Waterloo, Ont.). J. Polym. Sci., Part A-1; 10: No. 7, 2149-58(Jul 1972).

The γ-ray-initiated polymerization of styrene in the solid state was studied over the temperature range –35 to –55°C for samples exhaustively purified and dried to remove residual water ("dry" samples). Comparison with kinetic results previously reported for dry samples in the liquid state indicates a sharp decrease in the rate of polymerization resulting from the liquid to solid state transition. The molecular weight distributions for in-source polymerization at –35 and –40°C are bimodal in nature, and the appearance of a third peak is noticeable at –47 and –55°C. In the case of postpolymerization at –35°C the molecular weight distribution is bimodal as in the case of in-source samples. In the former case, however, the high molecular weight peak is predominant whereas the low molecular weight peak predominates in the latter. These results were tentatively attributed to the postulated coexistence of two distinct propagating species that are radical and cationic in nature. (auth)

47787 RADIATION-INDUCED POLYMERIZATION OF TETRAOXANE IN THE SOLID STATE. II. MOLECULAR

WEIGHT DISTRIBUTION. Nakase, Yoshiaki; Yoshida, Masaru; Ito, Akihiko; Hayashi, Koichiro (Japan Atomic Energy Research Inst., Takasaki). J. Polym. Sci., Part A-1; 10: No. 7, 2181-7(Jul 1972).

In order to investigate the mechanism of the radiation-induced postpolymerization of tetroxane in the solid state, the polymer was fractionated, and the fractions were characterized by reduced viscosity. The molecular weight of polymer formed in vacuo decreased drastically after the introduction of oxygen under conditions such that the polymer yield increased. The decrease in the molecular weight in the postpolymerization of tetroxane is attributed to degradation of the polymer in the presence of oxygen. It is suggested that at least peroxides formed by preirradiation contribute to both the increase in polymer yield and the decrease in molecular weight of the polymer. (auth)

47788 NMR AND ESR STUDIES OF THE SOLID-STATE POLYMERIZATION OF VINYL MONOMERS. I. ACRYLAMIDE. Chachaty, C.; Forchioni, A. (CEN de Saclay, Gif-sur-Yvette, France). J. Polym. Sci., Part A-1; 10: No. 7, 1905-22(Jul 1972).

The kinetics of the solid-state polymerization of acrylamide, γ-irradiated at 77°K, was studied by wide line NMR and by ESR at temperatures above 300°K. This reaction may be followed by the growth of a narrow line superimposed on the NMR spectrum of the monomer. The amplitude of this narrow line has been found to be proportional to the polymer yield. By long continued annealing, the conversion yield approaches a limiting value, generally lower than 50% under most of our experimental conditions. The activation energy of post-polymerization is 19 ± 1 kcal/mole. The radiochemical yield of radicals, determined by ESR, is 0.27 ± 0.03 at 77°K before warming. In the course of annealing above 300°K, the overall concentration of radicals is reduced to about one tenth of its initial value at 77°K. However, the local concentration of the remaining radicals is constant and equal to 1.2×10^{19} spins/g, i.e., more than 100 times their overall concentration. The recombination of radicals does not seem to intervene in the kinetics of post-polymerization, so that it may be assumed that only the radicals remaining after annealing have actually contributed to the reaction. (auth)

47789 NMR AND ESR STUDIES OF THE SOLID-STATE POLYMERIZATION OF VINYL MONOMERS. II. ACRYLIC ACID. Forchioni, A.; Chachaty, C. (CEN de Saclay, Gif-sur-Yvette, France). J. Polym. Sci., Part A-1; 10: No. 7, 1923-43(Jul 1972).

The post-polymerization of acrylic acid, γ-irradiated at 77°K, was studied by broad-line NMR and ESR between 240 and 286°K (mp). The changes in the structure of NMR spectra during the polymerization were related to the conversion yield checked by gravimetry of the polymer formed. The very fast reaction occurring above $\simeq$270°K was followed simultaneously by NMR and thermal analysis. This last method indicates an activation energy of chain propagation of 18.6 ± 2 kcal/mole in satisfactory agreement with the value given by the initial slope of the conversion-time curves. ESR experiments show that, while the average radical concentration decays by a factor of about ten between 77 and 240°K, the local concentration of radicals persisting after prolonged annealing at $T > 240$°K, remains the same as at 77°K, i.e., 1.4×10^{19} spins/g. A kinetic scheme, assuming an exponential decay of propagation and termination rate constants with chain length, was proposed to explain the shape of conversion–time curves as well as the almost constancy of the local concentration of growing polymer chains. (auth)

47790 ELECTRON PARAMAGNETIC RESONANCE SPECTROSCOPY OF γ-IRRADIATED CELLULOSE AND RELATED COMPOUNDS. Ahmed, A. U.; Rapson, W. H. (Univ. of Toronto). J. Polym. Sci., Part A-1; 10: No. 7, 1945-52(Jul 1972).

EPR studies were carried out on different irradiated cellulosic materials. The shape of the EPR spectrum was found to depend upon the fine structure of cellulose. The peak-to-peak distances of the large peaks on the differential curves were found to be 23.3 and 24.8 gauss, respectively, for the amorphous and recrystallized cellulose. The number of free radicals present per unit weight in the recrystallized cellulose and in the amorphous cellulose were found to be in the ratio of 2.1 : 1. The EPR spectrum of a sample of irradiated cotton crystallites which was soaked in acetone before being dried was markedly symmetrical, in contrast to the EPR spectra of samples of cotton linters and of cotton crystallites dried from water, and was considered to be a reflection of the lower intermolecular bonding in the former. For corresponding doses, the free radicals on cotton crystallites have the highest g value, followed by cotton linters, followed by regenerated cellulose I. The g value decreased as the irradiation dose was increased. (auth)

47791 GAS-PHASE COPOLYMERIZATION OF SULFUR DIOXIDE AND BUTENE-1. Brown, J. R.; O'Donnell, J. H. (Univ. of Queensland, Brisbane). J. Polym. Sci., Part A-1; 10: No. 7, 1997-2004(Jul 1972).

Mixtures of sulfur dioxide and 1-butene were polymerized in the gas phase to the 1 : 1 alternating copolymer by electron irradiation. The rate of polymerization, measured by the decrease in gas pressure, decreased with increase in temperature over the range −20 to +30°C. The initial G(-monomer) values decreased from 500 to 50 giving an Arrhenius activation energy of −30 kJ mol^{-1}. These results are consistent with a ceiling temperature–pressure relationship. The ceiling temperature is about 60°C lower than that observed previously in the liquid phase in accord with thermodynamic prediction. (auth)

47792 POLYMERIZATION OF VINYL STEARATE MULTILAYERS. Cemel, A.; Fort, Tomlinson Jr.; Lando, J. B. (Case Western Reserve Univ., Cleveland). J. Polym. Sci., Part A-1; 10: No. 7, 2061-83(Jul 1972).

A study was made of the solid-state polymerization of built-up monomolecular layers of vinyl stearate. Polymerization was initiated by exposing the samples to ^{60}Co γ-radiation. The reactions were followed by multiple internal reflection infrared spectroscopy. The structure of the multilayer monomer and polymer was studied by x-ray diffraction. Surface properties of the multilayers were studied by contact-angle measurements. Results showed that, under the proper conditions, monomer multilayers of vinyl stearate could be polymerized to virtually 100% completion. Reaction was favored by higher irradiation temperatures, larger doses of radiation, and by higher reaction temperatures. The x-ray diffraction photographs indicated that both the monomer and polymer multilayers possessed some single crystal character. Contact-angle measurements indicated that the molecules in both the monomer and polymer multilayers were closely packed. (auth)

47793 RADIATION CHEMICAL GRAFTING FROM MONOMER VAPOR PHASE OF POLYMERS ON THE SURFACES OF FILLER MATERIALS AS A METHOD OF THEIR ACTIVATION. Taubman, A. B.; Yanova, L. P.; Blyskosch, G. S.; Ryabchikova, G. G.; Glazunov, P. Yu. (Inst. of Physical Chemistry, Moscow). J. Polym. Sci., Part A-1; 10: No. 7, 2085-9(Jul 1972). (In German).

The vapor-phase radiation graft polymerization of styrene, methyl methacrylate, and acrylonitrile on the surface of dispersed filler (magnesium oxide) was studied. It was established that the polymer graft films are irreversibly chemically bound to the surface and cover it with a discontinuous layer which leaves a part of the surface free from polymer in the form of a mosaic. The grafting modifies the surface and increases the compatibility of filler with the polymer medium. (auth)

47794 IONIC REACTOR REACTIONS IN THE γ-RADIOLYSIS OF 1,4-DIOXANE. Kroh, J.; Hankiewicz, E.; Leszczynski, R. (Inst. of Radiation Chemistry, Lodz, Poland). Bull. Acad. Pol. Sci., Ser. Sci. Chem.; 20: No. 4, 343-8(1972).

The proton transfer processes in the system dioxane–tritiated water were studied. For water concentration (0.2 to 1.2) $\times 10^{-1}$ M the radiation yield of HT does not fulfill the Hummel equation for inhomogeneous scavenging. The yields G(H_2) and G(HT) fit well that equation in the case of electron scavenging, i.e., when electron scavengers (CCl_4, N_2O) are present in the system dioxane +0.1 M THO. Under these conditions the efficiency factor η for ion neutralization was estimated as 0.17. The reactivity coefficient α_{N_2O} in the system dioxane +0.1 M THO equals 12.9 M^{-1}. (auth)

47795 REACTIVITY OF CERTAIN AROMATIC COMPOUNDS WITH RESPECT TO THE OH RADICAL. Basinski, A.; Lerke, G. (Nicholas Copernicus Univ., Torun, Poland). Bull. Acad. Pol. Sci., Ser. Sci. Chim.; 20: No. 4, 319-22(1972).

Results of studies on the relation between the structure of aromatic compounds and their reactivity with respect to the OH radical obtained by radiolysis of water are reported. Aqueous solutions of toluenesulfonic acids were used in the investigation. The reactivity was determined by the competing acceptors method using for this purpose p-nitrosodimethylaniline. It was found that the OH radical attacks the methyl group of toluenesulfonic acids. The reactivity of the acids decreased in the order: meta > para > ortho. Relative and absolute values of rate constants of the reaction of the OH radical with toluenesulfonic acids were calculated. The probable mechanism of the effect of substituents in the benzene ring on the reactivity of the methyl groups is discussed. (auth)

47796 REACTOR RADIOLYSIS OF AQUEOUS SOLUTIONS OF PHOSPHORIC ACID, POTASSIUM BICARBONATE, AND THEIR MIXTURES. Bartonicek, Bohumil (Nuclear Research Inst., Rez, Czech.); Kubecek, Lubomir; Lukac, Sava. Jad. Energ.; 18: No. 7, 225-8(Jul 1972).

The radiolysis of aqueous H_3PO_4 and $KHCO_3$ solutions and their mixtures recommended for inhibition of corrosion of avial vessels of nuclear reactors were studied and hydrogen, oxygen, and hydrogen peroxide formation under reactor irradiation were followed. The presence of ingredients in water enhances the formation of radiolytic products. On the basis of experimental results the mechanism of the radiolytic decomposition of these systems at high doses of reactor radiation is discussed. (auth)

47797 SOME BIOLOGICAL INTERACTIONS STUDIED BY PULSE RADIOLYSIS TECHNIQUES. Davies, J. V. (Christie Hospital and Holt Radium Inst., Manchester, Eng.); Power, D. M.; Moore, J. S. Ann. Inst. Super. Sanita; 7: 605-12(1971).

It is shown that binding processes in biological reactions can be studied by pulse radiolysis. For the example of penicillin binding to proteins, the variation in the reaction rate of e_{aq}^- with proteins alone and when complexed with penicillin G was measured. Each molecule of penicillin complexed had an equal effect on e_{aq}^- reactivity up to 6 molecules, after which no further effect was noted. (M.C.G.)

47798 ELECTRON SPIN RESONANCE EVIDENCE FOR THE C–F BOND RUPTURE BY DISSOCIATIVE ELECTRON ATTACHMENT. Toriyama, Kazumi; Iwasaki, Machio (Government Industrial Research Inst., Nagoya, Japan). J. Phys. Chem.; 76: No. 13, 1824-6(22 Jun 1972).

To examine the possibility of the C–F bond rupture by dissociative electron attachment to fluorine, ESR study was carried out using irradiated glasses of 2-methyltetrahydrofuran containing small amounts of fluorinated compounds such as CFH_2CONH_2, CHF_2COOEt, CF_3CONH_2, CF_3COOEt, CF_3COOH, c-C_6F_{12}, and $CF_2ClCONH_2$. Among these, the first three compounds gave clear evidence that radicals are formed from the rupture of the C–F bond by electron attachment followed by the dissociative process. The results obtained from a series of compounds indicate that the partially fluorinated compounds are favorable to the dissociative electron attachment and that the electron-withdrawing tendency of the functional group is another important factor for the dissociative process. The results may suggest that the dissociative electron attachment plays an important role in the formation of radicals in some irradiated fluorine-containing compounds, although the cross section is not so large as compared with that in chlorine-containing compounds. (auth)

47799 PRECURSORS OF THE METAL-COMPLEXED HYDROPEROXYL RADICAL. Samuni, A. (Carnegie-Mellon Univ., Pittsburgh). J. Phys. Chem.; 76: No. 16, 2207-13(3 Aug 1972).

The precursors of the metal-complexed paramagnetic intermediates generated in the course of redox reactions of hydrogen peroxide with metal ions were studied by ESR spectroscopy using in situ radiolysis. The necessity of adding H_2O_2 and the interference of the resulting peroxy complexes were avoided. No complexed species were formed from the free metal ion in the absence of HO_2 radicals. However, when peroxy-metal complexes were present in the system both ·OH and $H\dot{O}_2$ gave rise to the same secondary species. The results indicate that the complexed radicals are formed through direct addition of $H\dot{O}_2$ radical to the metal ion as well as via one-electron oxidation of peroxy-metal complexes by ·OH and $H\dot{O}_2$. These results support the formulation of the species produced in all cases as M–O–O·. It was found also that Zr(IV) and Hf(IV) in each case react with $H\dot{O}_2$ to yield two different paramagnetic transients similar to those obtained from Ti(IV). (auth)

47800 REACTIVITIES OF SOLVATED ELECTRONS IN ETHYLENE GLYCOL–WATER GLASS. Steen, Harald B.; Kongshaung, Magne (Norsk Hydro's Inst. for Cancer Research, Oslo). J. Phys. Chem.; 76: No. 16, 2217-23(3 Aug 1972).

The effect of various electron-scavenging solutes, $CuCl_2$, H_2O_2, $NaNO_3$, CCl_3COONa, CCl_3COOH, and HCl, on the isothermal decay of stabilized electrons $(e_s^-)^2$ in ethylene glycol-water glass was studied at 123°K by continuous measurements of the optical density (OD) during and after X-irradiation. The decay kinetics of the OD were similar for all solutes indicating that e_s^- is the only diffusible species. The decay of OD was independent of wavelength over the major part of the absorption spectrum of e_s^-. The decay kinetics was nonexponential so that the rate of reaction of e_s^- with the various scavengers, which was derived on the basis of the observation that the scavenging kinetics is exponential with regard to solute concentration, decreased by a factor of 4 during the first 200 sec of the decay whereupon it became approximately constant. The reactivities of e_s^- with the various scavengers were not proportional to those of dry (e^-) or mobile electrons (e_m^-) previously measured in the same glass. In particular the hydronium ion, which reacted very slowly with e^- and e_m^-, was a very efficient scavenger of e_s^-. The results indicate that coulombic effects may possibly contribute to the difference between the reactivities of e^-, e_m^-, and e_s^-. (auth)

47801 WAVELENGTH DEPENDENCE OF PHOTOBLEACHING OF TRAPPED ELECTRONS IN 3-METHYLPENTANE GLASS. Miller, John R.; Willard, John E. (Univ. of Wisconsin, Madison). Contract AT(11-1)-1715. J. Phys. Chem.; 76: No. 16, 2341-2 (3 Aug 1972).

Bleaching experiments were carried out by observing, with repetitive scanning, the ESR signal height from γ-irradiated samples of 3-methylpentane glass while illuminating them in an ESR cavity. A microwave power of 10 μW was used, partially saturating the electron singlet but allowing use of a resistive termination to prevent any dispersive contribution to the signal. Illuminations were started about 5 min after the end of irradiation and were continued until about one-third of the electrons were bleached. (M.C.G.)

47802 COMPLEXITY IN ^{60}Co GAMMA RADIOLYSIS OF AQUEOUS SOLUTIONS OF ISOPROPANOL SATURATED WITH NITROUS OXIDE. Awan, M. H.; Chaudhri, S. A.; Farhataziz (Atomic Energy Centre, Lahore). Nucleus (Karachi); 8: No. 4, 87-93(1971).

For ^{60}Co γ radiolysis of N_2O-saturated aqueous solutions containing 10^{-2} to 10^{-3} M isopropanol, acetone is produced linearly and H_2O_2 nonlinearly reaching a steady-state concentration with absorbed dose for dose rates of 3.04×10^{20} to 0.45×10^{20} eV 1^{-1} min^{-1}. Increasing yields of acetone and lower steady-state concentrations of H_2O_2 are obtained for decreasing dose rate, and are independent of pH 4.3 to 9.2 of the isopropanol concentrations. The results indicate that the reaction $CH_3COHCH_3 + N_2O \rightarrow CH_3COCH_3 + N_2 + OH$ is operative in the system, $kCH_3\,COHCH_3 + N_2O/kCH_3COHCH_3 + H_2O_2 = 2.2 \times 10^{-4}$. A value of $g(e_{aq}^-) = 2.8$ for ^{60}Co γ rays was deduced for N_2O saturated aqueous solutions containing $\sim 10^{-2}$ M isopropanol. (auth)

47803 EXCITED TRIPLET MOLECULAR STATES IN RADIATION CHEMISTRY (A REVIEW). Alfimov, M. V. (Inst. of Chemical Physics, Moscow). High Energy Chem. (USSR) (Engl. Transl.); 6: No. 1, 1-14(1972).

Translated from Khim. Vys. Energ.; 6: No. 1, 3-20(1972).

Investigations of processes in which triplet-state molecules are formed by bombardment with ionizing radiation are reviewed. The entire series of processes involving the participation of the triplet state (mechanism for the formation of the triplet-state molecules, migration of triplet excitation, and bimolecular processes with the participation of triplet-state molecules) is systematically examined. (101 references). (J.G.B.)

47804 IONIC-MOLECULAR REACTIONS IN THE PHOTOIONIZATION OF HALOGEN DERIVATIVES OF BENZENE. Sergeev, Yu. L.; Akopyan, M. E.; Vilesov, F. I. (Scientific-Research Physical Inst., Leningrad. Leningrad State Univ.). High Energy Chem. (USSR) (Engl. Transl.) 6: No. 1, 15-18 (1972).

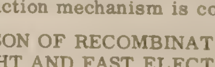
Translated from Khim. Vys. Energ.; 6: No. 1, 21-5(1972).

A mass spectrometer was used for photoionization studies of ionic–molecular reactions of chloro-, bromo-, and iodobenzenes in the ranges 10^{-6} to 10^{-4} and 10^{-4} to 10^{-2} torr. Reactions of association and transfer of heavy particles involving a molecular ion and a phenyl radical ion were identified. (auth)

47805 RADIATION CHLORINATION OF THE METHYL GROUP IN TOLUENE. II. THE EFFECT OF DOSE RATE AND TEMPERATURE. Ryabov, E. A.; Egunov, A. V.; Chertorizhskii, A. V.; Raichuk, F. Z.; Tovbin, Yu. K. (Inst. of Chemical Physics, Moscow). High Energy Chem. (USSR) (Engl. Transl.); 6: No. 1, 32-5(1972).

Translated from Khim. Vys. Energ.; 6: No. 1, 43-6(1972).

The rates of all three successive chlorination reactions of toluene to benzotrichloride $PhMe \xrightarrow{k_I} PhCH_2Cl \xrightarrow{k_{II}} PhCHCl_2 \xrightarrow{k_{III}} PhCCl_3$ are proportional to the radiation intensity to the 0.5 power. The effective activation energies of these reactions, which proved to be 3.4 ± 0.3, 5.6 ± 0.5, and 8.4 ± 0.5 kcal/mole for the formation of benzyl chloride, benzal chloride, and benzotrichloride, respectively, were determined on the assumption that the chlorine concentration remains constant during the chlorination process. The free valency indices and localization energy calculated by Huckel's method for radicals of the type



agree well with the values of the effective activation energy obtained. A possible reaction mechanism is considered. (auth)

47806 COMPARISON OF RECOMBINATION LUMINESCENCE INDUCED BY UV LIGHT AND FAST ELECTRONS. Kovalev, Yu. V.; Milyutinskaya, R. I.; Bagdasar'yan, Kh. S. (Inst. of

Chemical Physics, Moscow). High Energy Chem. (USSR) (Engl. Transl.); 6: No. 1, 36-8(1972).

Translated from Khim. Vys. Energ.; 6: No. 1, 47-50(1972).

The recombination luminescence (RL) kinetics of solutions of tetramethyl-p-phenylenediamine (TMPD) in dipropyl ether and in a 3 : 1 mixture of methylcyclohexane and isopentane at 77°K was investigated. RL was induced by fast electrons (2 MeV). The results are compared with uv-induced RL. Despite the different formation mechanisms of $TMPD^+$ for these two types of radiation, the kinetic characteristics of RL were very similar in both cases. It is concluded that for recombining particles of the same type (electron + $TMPD^+$), the RL characteristics are largely determined by the physical properties of the matrix. (auth)

47807 EFFECT OF LIGHT ON RADIATION CROSS-LINKING OF GLASSY ELASTOMERS OF VARYING STRUCTURE. Novikov, G. F.; Kozlov, V. T.; Frankevich, E. L. (Inst. of Chemical Physics, Moscow. Scientific-Research Inst. for the Rubber Industry, Moscow). High Energy Chem. (USSR) (Engl. Transl.); 6: No. 1, 39-41(1972).

Translated from Khim. Vys. Energ.; 6: No. 1, 51-4(1972).

The effects of photo-irradiation at 77°K (bleaching) on the amount of crosslinking measured in samples after thawing were studied for ten γ-irradiated (77°K) rubbers of varying structure. It was found that the bleaching of various elastomers leads to an increase, decrease, or practically no effect in the cross-link concentration. It is assumed that the observed "bleaching effect" results from the participation of ionized states in processes taking place after the radiolysis of the rubbers studied, and a possible explanation is given for the sign of this effect on the basis of the participation of ionized states in both the formation of cross-links and in the dissociation of "strained" bonds which are formed in the course of low-temperature radiolysis. (auth)

47808 THEORY OF PULSE RADIOLYSIS IN AN ELECTRICAL FIELD. Sharanin, Yu. I.; Shubin, V. N.; Dolin, P. I. (Inst. of Electrochemistry, Moscow). High Energy Chem. (USSR) (Engl. Transl.); 6: No. 1, 42-5(1972).

Translated from Khim. Vys. Energ.; 6: No. 1, 55-9(1972).

Equations for calculating the following radiation-chemical parameters of charged particles were derived: yield of charged particles, their mobility, and rate constants of the reactions in which they participate under conditions of pulse irradiation in strong electrical fields. In the case of crystalline ice, both high and low doses were examined. The calculations were made under the assumption of a two-charge model for the radiolysis of ice. The limits of the applicability of this method were studied. The calculated results are compared with the experimental data. (auth)

47809 KINETIC CHARACTERISTICS OF THE WATER–NITROUS OXIDE–HYDROGEN SYSTEM IN A PERIODIC RADIATION FIELD. Frunze, T. A.; Kabakchi, S. A.; Shubin, V. N.; Dolin, P. I. (Inst. of Electrochemistry, Moscow). High Energy Chem. (USSR) (Engl. Transl.); 6: No. 1, 46-8(1972).

Translated from Khim. Vys. Energ.; 6: No. 1, 60-2(1972).

The action of periodic radiation at various dose rates was studied on the system $N_2O-H_2-H_2O$. In a study of neutral and alkaline solutions, a dependence of total pressure change of radiolysis products on dose rate was established. On the basis of the dependence obtained, the rate constants of some reactions were determined. (auth)

47810 CHEMINUCLEAR SYNTHESIS OF NITROGEN TRIFLUORIDE. Baronov, G. C.; Dmitrievskii, V. A.; Migachev, A. I.; Cherednikov, V. N. High Energy Chem. (USSR) (Engl. Transl.); 6: No. 1, 51-3(1972).

Translated from Khim. Vys. Energ.; 6: No. 1, 65-8(1972).

It was found that uranium hexafluoride can be used in the cheminuclear synthesis of appreciable quantities of nitrogen trifluoride. More than 100 g of this compound was produced from nitrogen and fluorine in laboratory equipment. (auth)

47811 α-RADIOLYSIS OF HNO_3 SOLUTIONS AND ACID $NaNO_3$ SOLUTIONS. Vladimirova, M. V.; Milovanova, A. S. High Energy Chem. (USSR) (Engl. Transl.); 6: No. 1, 54-7(1972).

Translated from Khim. Vys. Energ.; 6: No. 1, 69-72(1972).

The α-radiolysis of HNO_3 solutions and of acid solutions of $NaNO_3$ was investigated. The radiation yield of HNO_2 as a function of dose intensity, NO_3^- ion concentration, acidity of solutions and HNO_3 concentration was determined. Kinetic calculations, confirmed experimentally, showed that $G(HNO_2)$ depends on the dose intensity at given values of acidity and concentration. When the dose intensity is varied from 10^{16} to 10^{14} eV/ml · min, $G(HNO_2)$ decreases. This decrease is the more marked, the higher the acidity of the solution and the absorbed dosage. The initial yield of HNO_2, both calculated and experimental, depends only on the NO_3^- ion concentration, for HNO_3 solutions and for $NaNO_3$ solutions of any acidity value. When $[NO_3^-]$ is varied from 0.1 to 4.0M, $G(HNO_2)$ increases from 0.6 to 2.4 in deaerated solutions, and from 0 to 2.0 in aerated solutions. (auth)

47812 RADICALS FORMED DURING γ-IRRADIATION OF ALKYL HALIDES IN UREA. Kuleshov, A. N.; Trofimov, V. I.; Chkheidze, I. I. (Inst. of Chemical Physics, Moscow). High Energy Chem. (USSR) (Engl. Transl.); 6: No. 1, 66-7(1972).

Translated from Khim. Vys. Energ.; 6: No. 1, 82-3(1972).

EPR methods were used for studying radicals formed during γ irradiation at 77°K of channel inclusion compounds of urea with alkyl halides (methyl, ethyl, and n-propyl iodides and bromides), which decompose below room temperature. It was found that in virtually all of these compounds alkyl radicals recombine in urea at higher temperatures than in the alkyl halide matrix. It is noted that paramagnetic particles other than alkyl radicals are formed during irradiation. EPR spectra are presented. (J.G.B.)

47813 RADIATION-CHEMICAL TRANSFORMATIONS IN SOLID EPOXY-BISPHENOL A RESINS OBTAINED FROM 4,4'-DIHYDROXYDIPHENYLPROPANE AND EPICHLOROHYDRIN. Sidyakin, P. V.; Karpov, V. L.; Egorov, V. N. High Energy Chem. (USSR) (Engl. Transl.); 6: No. 1, 68-9(1972).

Translated from Khim. Vys. Energ.; 6: No. 1, 84-5(1972).

The formation of carbonyl groups and hydrogen in epoxy-bisphenol A resins (EBPs) as a result of the action of γ irradiation was studied. After irradiation the solids were studied by ir spectroscopy and the gaseous products of the radiolysis by mass spectrometry. A mechanism for the formation of carbonyl groups in an irradiated solid EBP is proposed. (J.G.B.)

47814 INITIAL YIELDS OF HYDROGEN PEROXIDE IN THE γ-RADIOLYSIS OF AQUEOUS SOLUTIONS OF BENZENE IN THE PRESENCE OF OXYGEN. Kartasheva, L. I.; Pikaev, A. K. (Inst. of Physical Chemistry, Moscow). High Energy Chem. (USSR) (Engl. Transl.); 6: No. 1, 76-7(1972).

Translated from Khim. Vys. Energ.; 6: No. 1, 90-1(1972).

The effects of dosage on the yields of H_2O_2 from the γ radiolysis of aqueous benzene solutions containing oxygen were studied. The decrease in $G(H_2O_2)$ with increasing dosage may be attributed to competition between H_2O_2 and O_2 for e_{aq}^- and reactions of H_2O_2 with organic radicals, carbonyl compounds, etc. (J.G.B.)

47815 INHIBITION OF RADIATION-INDUCED OXIDATION BY STABLE IMINOXYL RADICALS. Romantsev, M. F.; Lysun, N. V.; Sudnik, M. V.; Pavelko, G. F. High Energy Chem. (USSR) (Engl. Transl.); 6: No. 1, 88-9(1972).

Translated from Khim. Vys. Energ.; 6: No. 1, 100-1(1972).

The γ-radioinduced oxidation of n-octane in the presence of stable iminoxyl radicals was studied at 0 and 100°C. Results indicate that stable iminoxyls are active acceptors of free radicals formed on radiolysis and can be used as inhibitors of radioinduced oxidation. (J.G.B.)

47816 ESR STUDY OF γ-IRRADIATED ISOBUTYLENE-SILICA GEL SYSTEM. Nagai, Siro; Ohnishi, Shun-ichi; Nitta, Isamu (Japan Atomic Energy Research Inst., Neyagawa). Bull. Chem. Soc. Jap.; 45: No. 6, 1934-5(Jun 1972).

ESR studies were made of free radicals produced in the γ-irradiated isobutylene–silica gel system. The asymmetric linewidth variation of the hf lines is explained in terms of a modulation of the anisotropic hyperfine and g-tensor interactions. Results indicate that the condensation of isobutylene molecules occurs inhomogeneously on the surface of silica gel before irradiation. (M.C.G.)

47817 GRAFT COPOLYMERS OF CELLULOSE AND VINYLIC KETONES. I. PREPARATION OF POLY(METHYL VINYL KETONE)–COTTON CELLULOSE COPOLYMERS. Reine, Alden H.; Arthur, Jett C. Jr; George, McLean (Dept. of Agriculture, New Orleans). J. Appl. Polym. Sci.; 16: No. 8, 1893-9(Aug 1972).

The graft copolymerization reaction of methyl vinyl ketone from several solvents with fibrous cotton cellulose, preirradiated to a dosage of 5.2×10^{19} ev/g with γ-radiation from ^{60}Co, was investigated. Solvents included water, methanol, N,N-dimethylformamide, and several combinations of these solvents. From water a maximum yield of copolymer product was obtained after 2 hr at 25°C. The addition of methanol to aqueous solutions of methyl vinyl ketone, in all concentrations, inhibited the graft copolymerization reaction. The addition of a small amount of N,N-dimethylformamide to aqueous solutions of the monomer increased the rate of the copolymerization reaction; however, the addition of large amounts of N,N-dimethylformamide to these solutions also inhibited the reaction. From solutions of methanol or N,N-dimethylformamide and monomer, little or no copolymerization of monomer with irradiated cellulose occurred. The copolymer products exhibited a strong infrared absorption band at 5.85 μ which is characteristic of the $-C=O$ group of the grafted poly (methyl vinyl ketone). Fibrous copolymer yarns exhibited increased yarn number and decreased breaking strength and average stiffness, as compared with unmodified cotton yarns. (auth)

47818 CHEMICAL EFFECTS OF THE (n,γ) REACTIONS IN CHLOROPENTAAMMINE, TRANS-DICHLOROTETRAAMMINE AND TRANS-DICHLOROBISETHYLENEDIAMINE CHLORIDES OF COBALT(III), RHODIUM(III) AND IRIDIUM(III). Gardner, E. R.; (Leicester Polytechnic, Eng.); Wilson, M. E.; Harding, R. D.; Raynor, J. B. Radiochim. Acta; 17: No. 1, 41-5(May 1972).

Chemical effects of the (n,γ) reaction were studied in cobalt (III), rhodium(III), and iridium(III), chloropentaammine, trans-dichlorotetraammine, and trans-dichlorobisethylenediamine chlorides. These complexes were labeled in the cation or the anion with ^{38}Cl. Irradiations were carried out in a thermal neutron flux of $2.4 \cdot 10^{11}$ neutron cm^{-2} sec^{-1} for various periods of time. The order of stability of metal–ligand–chlorine bond was cobalt > rhodium > iridium. For cobalt and rhodium the order of stability of the complexes is trans-$[M(NH_3)_4Cl_2]Cl$ > trans$[M(en)_2Cl_2]Cl$ > $[M(NH_3)_5Cl]Cl_2$; for iridium the order is reversed. (auth)

47819 DEUTERIUM ISOTOPE EFFECTS IN RADIOLYSIS OF ORGANIC COMPOUNDS. Rummel, S. (Zentralinstitut fuer Isotopen- und Strahlentechnik, Berlin). Isotopenpraxis; 8: No. 3, 77-88(Mar 1972). (In German).

Exploration of kinetic deuterium isotope effects offers possibilities of obtaining knowledge of the complex mechanism of these reactions. Use of deuterium isotope effects in radiolysis of organic compounds with regard both of yield and the different elementary reactions shows that the comparatively insignificant difference in zero-point vibration energy of C–H and C–D even in the reactions of electron-excited molecules exerts a significant influence on the velocity of running processes. Isotope effects must be taken into consideration in kinetic processes in which deuterium or tritium are involved. (auth)

47820 ISOPROPANOL RADIATION-THERMAL TRANSFORMATIONS IN THE PRESENCE OF CARBONYL COMPOUNDS. Afanas'ev, A. M.; Kalyazin, E. P. Vestn. Mosk. Univ., Ser. II. Khim.; 13: No. 2, 232-4(1972). (In Russian).

Radiolysis of liquid isopropanol containing acetaldehyde or acetone (2 wt %) was investigated in temperature range 30 to 205°C. Acetaldehyde chain decomposition to methane and carbon monoxide, simultaneous acetaldehyde reduction to ethanol, and isopropanol oxidation to acetone were found to proceed at high temperatures in acetaldehyde solutions. (auth)

47821 GAMMA-RAY INDUCED REACTION OF CYCLOHEXANONE IN THE PRESENCE OF CHLORINATED HYDROCARBONS. Yumoto, Takaari (Government Industrial Research Inst., Nagoya, Japan)· Matsuda, Tatsuo. Nippon Kagaku Kaishi; 1972: No. 5, 940-4(May 1972). (In Japanese).

Cyclohexanone was γ irradiated in the presence of some chlorinated hydrocarbons. The main products were confirmed to be 2-(1-cyclohexenyl)cyclohexanone [1] and 2,6-di(1-cyclohexenyl) cyclohexanone [2]. Any expected condensation product between cyclohexanone and chlorinated hydrocarbons was not detected. The rates of formation of [1] and [2] were found to be nearly proportional to the dose rate. A maximum yield of 47.5% of [1] was obtained in the presence of 20% moles of tetrachloroethylene. The effect of the coexistence of chlorinated hydrocarbons on the yields of [1] and [2] decreased in the order: tetrachloroethylene > trichloroethylene > cis-1,2-dichloroethylene, carbon tetrachloride > chloroform > methylene chloride > 1,1-dichloroethane. The reaction mechanism of the formation of [1] and [2] is discussed. (auth)

47822 CONTINUOUS RADIOVULCANIZATION. Puig, J. R. (Centre d'Application et de Promotion des Rayonnements Ionisants, Gif-sur-Yvette, France). Rev. Gen. Caout. Plast.; 49: No. 4, 289-93(Apr 1972). (In French).

Radiovulcanization avoids the inconvenience of having to incorporate vulcanization agents in the material to be vulcanized and having to heat the material. The technique is applicable to most elastomers and plastics and suitable for continuous vulcanization. The advantages and disadvantages of irradiation techniques, and their possible applications are discussed. (France)

47823 ESR STUDY OF MnO_4^{2-} IN γ-IRRADIATED $KMnO_4$. Subramanian, S.; Rogers, Max T. (Michigan State Univ., East Lansing). J. Chem. Phys.; 57: No. 5, 2192-8(1 Sep 1972).

When $KMnO_4$ is γ irradiated at 77°K, a single paramagnetic species is detected which is shown to be basically the manganate ion, Mn(VI)O_4^{2-}; however, the single odd electron interacts at the same time with a second manganese nucleus of a neighboring diamagnetic species. Although the species giving rise to the weaker, superhyperfine ^{55}Mn interaction could not be identified with certainty, it is probably a neighboring MnO_4^- ion or MnO_3^+ lattice defect so that the center produced might be written [Mn(VI)O_4^{2-} . . . Mn(VII)O_n^{7-2n}]. The g tensor and both ^{55}Mn hyperfine splitting tensors are obtained, and the structure of the radical is discussed. On warming to room temperature a radical not containing manganese, probably O_3^-, is found. (auth)

47824 PULSE RADIOLYSIS OF NEOPENTANE IN THE GAS PHASE. Rebbert, R. E.; Ausloos, P. (National Bureau of Standards, Washington, D. C.). J. Res. Nat. Bur. Stand.; 76A: No. 4, 329-36(1972).

The pulse radiolysis of gaseous neopentane was investigated in the absence and presence of electron scavengers (SF_6, CD_3I, CCl_4). Deuterium labeling experiments show that the stable product molecules can be accounted for by (a) radical combination reactions involving mainly CH_3 and H; (b) hydride ion transfer reactions involving $C_2H_3^+$, $C_2H_5^+$, and $C_3H_5^+$; (c) neutralization reactions of $C_4H_9^+$ and $C_5H_{11}^+$; and (d) unimolecular dissociation of the parent ion ($C_5H_{12}^+$) and of electronically excited neopentane. Neutralization of the t-$C_4H_9^+$ ion, which is the major positive ion in the system, occurs as follows: (a) t-$C_4H_9^+ + e \rightarrow$ i-$C_4H_8 + H$ and (b) t-$C_4H_9^+ + e \rightarrow 2CH_3 + C_3H_6$. It is shown that $C_5H_{11}^+$ produced in hydride ion transfer reaction $C_nH_m^+$ + neo-$C_5H_{12} \rightarrow C_nH_{m+1} + C_5H_{11}^+$ (where $C_nH_m^+$ = $C_2H_3^+$, $C_2H_5^+$, and $C_3H_5^+$) rearranges to the $CH_3C^+(CH_3)CH_2CH_3$ structure prior to neutralization. A detailed accounting of all products produced in the unimolecular and bimolecular reactions led to the conclusion that the ratio of neutral electronically excited molecules to parent ions (N_{ex}/N_+) is 0.28. (auth)

47825 HIGH ENERGY RADIATION STABILIZATION OF CELLULOSE OBTAINED BY ESTERIFYING WITH FUROYL CHLORIDE. Arthur, Jett C. Jr.; Singh, Sujan; Hinojosa, Oscar (to Secretary of Agriculture). U. S. Patent 3,677,692. 18 Jul 1972. Filed 30 Apr 1971.

A method for stabilizing organic materials that contain the glycosidic bond to the effects of high energy radiation is described. Stabilization is achieved by the introduction of furoate groups as substituents into the organic material. Modification of the chemical structure of organic materials that contain the glycosidic bond allows preferential transfer of high energy from one part of the organic material to the furoate substituent group. (auth)

47826 GAMMA RAY-INDUCED LIQUID-STATE POLYMERIZATION OF HEXAMETHYLCYCLOTRISILOXANE AND OCTAMETHYLCYCLOTETRASILOXANE. Chawla, A. S.; St. Pierre, L. E. (McGill Univ., Montreal). J. Appl. Polym. Sci.; 16: No. 8, 1887-91(Aug 1972).

The radiation-induced bulk polymerization of liquid hexamethylcyclotrisiloxane was achieved. Appreciable yields of polymer from octamethylcyclotetrasiloxane liquid were also obtained. These results were achieved on "ultra-dry" monomers and are interpreted in terms of an ionic polymerization mechanism. (auth)

47827 CONFIRMATION OF A σ-RADICAL IN X-IRRADIATED MALONAMIDE. Straw, David C.; Moulton, Grace C. (Florida State Univ., Tallahassee). J. Chem. Phys.; 57: No. 5, 2215-16 (1 Sep 1972).

The assignment of a σ-electron to the malonamide radical NH_2COCH_2CONH was confirmed. Single crystals of malonamide were x-irradiated and the ESR spectra were observed. The σ-orbital unpaired electron was substantiated by the fact that the eigenvector corresponding to the largest nitrogen coupling is situated approximately parallel to the C—C—C plane of the molecule. (M.C.G.)

47828 RESOLUTION OF THE ABSORPTION SPECTRUM OF SOLVATED ELECTRONS. Lugo, Roberto; Delahay, Paul (New York Univ., N. Y.). J. Chem. Phys.; 57: No. 5, 2122-9(1 Sep 1972).

The absorption spectrum of solvated electrons is resolved by superposition of one or several Gaussian-shaped bound–bound (bb) bands and one bound-continuum (bc) band. A previously derived equation is applied for the bc band. Energy levels, band amplitudes, widths, and contributions are given for tetrahydrofuran, ethylenediamine, hexamethylphosphoric triamide, water (all at room temperature), ammonia (−65°C), and 3-methylpentane (77°K). Resolution is tentative for ethylenediamine because of insufficient experimental data and for ammonia and water because of inadequacy of the equation for the bc band. Experimental evidence supports this equation for all solvents except ammonia and water. A theoretical limitation is indicated. Energy levels are correlated with the nature of the solvent as characterized by the difference β between the reciprocals of the optical and static dielectric constants. Spectra of solvated electrons in solvents with low β's show a major contribution from the bc transition and only one bb transition. Conversely, a high β results in a more complex spectrum with a relatively minor bc contribution. (auth)

47829 TEMPERATURE DEPENDENCE OF THE ESR SPECTRUM FROM A TUNNELING METHYL GROUP. Davidson, R. B.; Miyagawa, Ichiro (Univ. of Alabama, Tuscaloosa). J. Chem. Phys.; 57: No. 5, 1815-17(1 Sep 1972).

The electron spin resonance spectrum for the unstable radical CH_3CHR in irradiated L-alanine was observed from 4.2 to 80°K. The hyperfine lines for $M_I = \pm 1/2$ showed relative maxima in peak intensity at 11°K when partially saturated. The presence of the maxima was interpreted in terms of spin-diffusion and Brownian mixing. (auth)

47830 GAS PHASE PULSE RADIOLYSIS OF HYDROCARBON MIXTURES; DETERMINATION OF THE CHARGE RECOMBINATION RATE COEFFICIENT AND ABSOLUTE RATE CONSTANTS OF ION–MOLECULE REACTIONS OF THE t-BUTYL ION THROUGH A COMPETITIVE KINETIC METHOD. Lias, S. G.; Rebbert, R. E.; Ausloos, P. (National Bureau of Standards, Washington, D. C.). J. Chem. Phys.; 57: No. 5, 2080-6(1 Sep 1972).

The gas-phase pulse radiolysis of several neopentane-d_{12}–alkane mixtures was studied to examine the competition between the reaction of the fragment t-butyl ion with the alkane to form isobutane, $t\text{-}C_4D_9^+ + RH_2 \rightarrow i\text{-}C_4D_9H + RH^+$, and the neutralization of the t-butyl ion by an electron or SF_6^- ion, $t\text{-}C_4D_9^+ + X^- \rightarrow$ products. Using a computer calculation, which takes into account the pulse characteristics as a function of time, the yield of isobutane observed in the reaction with 2,3-dimethylbutane (for which k_{rn} was accurately determined to be $5.7 \pm 0.5 \times 10^{-11}$ cm^3/molecule·sec) and the dose per pulse, rate coefficients of the competing neutralization reactions were determined. These are $\alpha = 1.92 \pm 0.2 \times 10^{-6}$ cm^3/molecule·sec for neutralization by an electron, and $0.40 \pm 0.04 \times 10^{-6}$ cm^3/molecule·sec for neutralization by the SF_6^- ion. The latter value is independent of SF_6 concentration and both are independent of pressure between 40 and 200 torr. These values of the neutralization rate coefficients and yields of isobutane measured in the pulse radiolysis of neopentane in the presence of other added alkanes were used to calculate absolute rate coefficients of the hydride transfer reactions between the $t\text{-}C_4D_9^+$ ion and these compounds; the values determined are in good agreement with those measured by other techniques. The unique feature of the competitive method consists of the fact that the positive ion that is neutralized can be identified by the conventional analysis of a known reaction product. (auth)

47831 THEORY OF RADIOLYSIS OF n-HEPTANE. Barba, Maria Cristina Pina. Mexico City; Univ. Nacional Autonoma de Mexico (1971). 91p. (In Spanish).

Thesis.

A brief explanation is presented of the formation of radiolytic products of n-heptane as a function of a simple model of chemical reactions induced by radiation taking into account the behavior of radicals and excited molecules. It was necessary to analyze the bases of the interaction of the radiation with the material and the experimental results obtained on irradiation n-heptane with 1-MeV electrons as well as those obtained in studying the variation in lifetimes of the different excited species formed during irradiation. Considering the different reactions between active species, a model was sought to explain the phenomena that resulted. On these bases the experimental results obtained were compared with those predicted by the model. (tr-auth)

47832 PRIMARY YIELDS AND MECHANISMS IN THE RADIOLYSIS OF N_2O FROM HIGH INTENSITY ELECTRON PULSE IRRADIATIONS OF N_2O–O_2 MIXTURES. Willis, C.; Boyd, A. W.; Bindner, P. E. (Atomic Energy of Canada Ltd., Chalk River, Ont.). Can. J. Chem.; 50: No. 10, 1557-67(15 May 1972). (AECL-4175).

The yields of N_2, O_2, NO, and O_3 were measured from the Febetron radiolysis of N_2O–O_2 mixtures with and without SF_6. A mechanism consistent with the yields from 0 to 100% O_2 and with known ionic abundances and reaction rate data was derived. The major features of this mechanism are both dissociative neutralization of N_2O^+ and excitation of N_2O to give $N_2(X^1\Sigma)$ and $O(^1D)$ and smaller amounts of $N_2(B^3\Pi)$ and $O(^3P)$. The large yields of NO and N_2 observed were mainly due to reaction of $O(^1D)$ with N_2O to give both N_2 and O_2 and NO. (auth)

47833 FREE RADICAL PHOTOCHEMISTRY. MONOCARBOXYLIC ACID ANHYDRIDE RADICALS. Chervonenko, V. S.; Roginskii, V. A. (Inst. of Physical Chemistry, Moscow). High Energy Chem. (USSR) (Engl. Transl.); 6: No. 1, 82-3(1972).

Translated from Khim. Vys. Energ.; 6: No. 1, 95-6(1972).

EPR spectra, low-temperature uv spectroscopy, and gas chromatography were used in an investigation of the photochemical reactions of radicals in acetic, propionic, and butyric anhydrides. EPR spectra are given for radicals formed after γ irradiation, photoirradiation at λ ≥ 450 nm and 24 h storage in the dark at 77°K, and those treated with subsequent uv irradiation. (J.G.B.)

47834 γ-RADIOLYSIS OF CYCLOHEXANOL SOLUTIONS OF CERTAIN ALIPHATIC ALDEHYDES. Ladygin, B. Ya.; Brui, O. I. (State Scientific-Research and Design Inst. of the Nitrogen Industry and Organic Synthesis Products, Moscow). High Energy Chem. (USSR) (Engl. Transl.); 6: No. 1, 80-1(1972).

Translated from Khim. Vys. Energ.; 6: No. 1, 93-5(1972).

Kinetics of the formation of caproaldehyde, n-hexanol, n-pentane, carbon monoxide, and cyclohexanone from the γ-induced isomerization of liquid cyclohexanol was studied at 125 to 250°C. The radiolysis of vacuum-treated cyclohexanol solutions of two aliphatic aldehydes, isobutyraldehyde and n-valeraldehyde, was also studied. Radiolysis products were analyzed chromatographically. (J.G.C.)

47835 RADIATION-CHEMICAL SYNTHESIS OF DIALKYLTIN DIBROMIDES. III. REACTION OF BUTYL BROMIDE WITH METALLIC TIN IN THE PRESENCE OF MAGNESIUM AND ZINC. Miretskii, V. Yu.; Vereshchinskii, I. V.; Pozdeev, V. V. (Inst. of Chemical Physics, Moscow). High Energy Chem. (USSR) (Engl. Transl.); 6: No. 1, 70-1(1972).

Translated from Khim. Vys. Energ.; 6: No. 1, 85-6(1972).

The effects of additions of Mg and Zn on the formation of dibutyltin dibromides and tributyltin bromides from the γ-radio-induced reaction of butyl bromide with tin in the presence of butanol were studied. Composition of the products varied considerably depending on whether the metals were added before or after irradiation. (J.G.B.)

47836 TEMPERATURE CHANGES IN THE EPR SPECTRUM OF THE 2-HYDROXYPROPYL RADICAL IN VARIOUS MATRICES. Kuleshov, A. P.; Trofimov, V. I. (Inst. of Chemical Physics, Moscow). High Energy Chem. (USSR) (Engl. Transl.); 6: No. 1, 63-5(1972).

Translated from Khim. Vys. Energ.; 6: No. 1, 79-81(1972).

Further studies were conducted on free radicals stabilized in the cavities and channels of inclusion compounds. Studies were performed on the 2-hydroxypropyl radical formed by the γ irradiation of acetone inclusion compounds with p-(2,2,4-trimethyl-4-chromanyl)phenol (Dianin's compound) at 77 to 170°K. For comparison radicals formed during the γ irradiation of a solid aqueous solution of acetone were also studied. EPR spectra are presented. (J.G.B.)

47837 EPR INVESTIGATION OF THE RADIOLYSIS PRODUCTS OF BARIUM AND CALCIUM SELENITES. Medvedev, A. S.; Gromov, V. V.; Shtan'ko, V. F. (Inst. of Physical Chemistry, Moscow). High Energy Chem. (USSR) (Engl. Transl.); 6: No. 1, 49-50(1972).

Translated from Khim. Vys. Energ.; 6: No. 1, 63-4(1972).

Various paramagnetic particles, a large portion of which are SeO_2^- and SeO_3^- radicals, are formed by the action of ^{60}Co rays in selenite crystals. The SeO_2^- radical is stable in the samples at room temperature. The g factors of SeO_2^- and SeO_3^- ion radicals were determined. (auth)

47838 VISCOSITY OF SOLUTIONS OF GRAFTED COPOLYMERS IN MIXED SOLVENTS. Tashmukhamedov, S. A.; Sardullaev, B. U.; Tillaev, R. S. (Tashkent State Univ.). Uzb. Khim. Zh.; No. 1, 63-5(1972). (In Russian).

The change in viscosity of the grafted copolymer of cellulose diacetate (rigid chain polymer) with poly(vinyl acetate) (flexible chain) was investigated in the systems: acetone–methanol and acetone–benzene. The grafted copolymers were synthesized using γ radiation from ^{60}Co, and possessed consistently smaller viscosities in the mixed solvents than similar solutions of the individual polymers. (K.S.W.)

47839 CHEMISTRY OF ORGANIC FLUORINE COMPOUNDS. XIII. RADICALIC ADDITION OF 2-PROPANOL AND 2-BUTANOL TO TRIFLUOROCHLOROETHYLENE. Liska, F.; Nemec, M.; Dedek, V. (Inst. of Chemical Tech., Prague). Collect. Czech. Chem. Commun.; 37: No. 6, 2091-9(Jun 1972).

On photochemical addition of 2-propanol to trifluorochloroethylene the same products were formed as when initiation was carried out with organic initiators or ^{60}Co γ radiation. From the addition of 2-butanol initiated by ultraviolet and ^{60}Co γ radiation telomeric alcohols 3-methyl-4,4,5,6,6,7-hexafluoro-5,7-dichloro-3-heptanol and 3-methyl-4,4,5,6,6,7,8,8,9-nonafluoro-5,7,9-trichloro-2-nonanol were isolated in addition to 3-methyl-1,2,2-trifluoro-1-chloro-3-pentanol. As reduction products 3-methyl-4,4,5,6,6,7-hexafluoro-7-chloro-3-heptanol and 3-methyl-4,4,5,6,6,7,8,8,9-nonafluoro-9-chloro-3-nonanol were identified. (M.C.G.)

47840 BIOLOGICAL ASPECTS OF ELECTROCHEMISTRY. Proceedings of the 1st International Symposium, Rome, Italy, May 31–June 4, 1971. Milazzo, Giulio; Jones, Peter E.; Rampazzo, Liliana (eds.). Experientia Supplementum 18. Basel; Birkhaeuser Verlag (1971). 722p. sfr. 128.–. (In several languages). (CONF-710554).

Sixty-seven papers presented at the conference are included. A separate abstract was prepared for one of the papers. (J.G.B.)

For an abstract of an individual paper see: 47841.

47841 EFFECT OF X AND γ-IRRADIATION ON HEMOGLOBIN A REDOX SYSTEM. Leyko, W.; Wiszkowska, H.; Puchala, M. (Univ. of Lodz, Poland). Experientia; Suppl. No. 18, 407-11(1971).

From first international symposium on biological aspects of electrochemistry; Rome, Italy (31 May 1971). See CONF-710554.

The effect of irradiation on human hemoglobin A solutions was investigated by two methods: estimation of redox potential by the method of Behlke and Scheler and recording of the absorption spectra. In the case of the redox reaction, from the titration curves free energy values and then other thermodynamic values may be calculated. A decrease of n value, following irradiation, was observed for the doses in the range of 10^5 rad. For lower doses, the first change, possible to observe by the methods used, was the gradual passing of oxyhemoglobin into methemoglobin spectrum. (auth)

47842 RADIOACTIVE KRYPTONATES OF ORGANOSULFUR COMPOUNDS. V. RADIO-RELEASE STUDY OF RADIATION STABILITY OF 4-BROMO-4'-ISOTHIOCYANATODIPHENYL SULFIDE. Uher, M.; Toelgyessy, J.; Lesny, J.; Piatrik, M.; Varga, S. (Technical Univ., Bratislava). Radiochem. Radioanal. Lett.; 9: No. 5-6, 351-5(31 Mar 1972).

Preparation of the radioactive kryptonate of 4-bromo-4'-isothiocyanatodiphenyl sulfide by means of a microdiffusion technique and the study of its radiation stability on exposure to γ radiation from ^{60}Co (dose rate ~0.45 Mrad/h) are discussed. It was found that irradiation for 175 hr (absorption dose ~76.5 Mrad) had no influence on the compound studied. (auth)

47843 RADIATION-INDUCED ADDITION REACTION OF SOME HYDROSILANES TO POLYFLUOROCYCLOBUTENES AND -CYCLOPENTENES. Ueda, Teruo; Muramatsu, Hiroshige; Inukai, Kan (Government Industrial Research Inst., Nagoya, Japan). Nippon Kagaku Kaishi; No. 3, 602-8(Mar 1972). (In Japanese).

The γ induced addition reactions of several silanes, $HSiCl_2C_6H_5$ (Ph), $HSiCl_3$(Cl), $HSiCl_2CH_3$(Me), $HSiCl(CH_3)_2$(Me$_2$) and $HSi(C_2H_5)_3$ (Et$_3$) to polyfluorocycloalkenes, $(CF_2)_nCCl = CH$ {n = 2 [1], n = 3 [2]} and $(CF_2)_nCCl = CCl$ {n = 2 [3], n = 3 [4]} were studied. While the 2,2-dihydropolyhalocycloalkylsilanes were obtained together with the corresponding 1 : 1 adducts in the addition of silanes to [1] or [2], the addition to [3] or [4] gave both the dehydrochlorinated 1 : 1 adducts and the 1 : 2 adducts. The apparent reactivities of the polyfluorocycloalkenes and the silanes were found to be in the following order, respectively: $(Et_3) \gg (Me_2) \geqq (Me) > (Cl) \gg (Ph)$. The direction of attack of the silyl radical on the unsymmetrical cycloalkenes and the reaction mechanisms is discussed. (auth)

47844 RADIOLYSIS OF LIQUID 2,2,4-TRIMETHYLPENTANE. KINETICS OF SCAVENGING PROCESSES. Rzad, Stefan J.; Bansal, Krishan M. (Carnegie-Mellon Univ., Pittsburgh). J. Phys. Chem.; 76: No. 17, 2374-80(17 Aug 1972).

The methyl radical yield observed upon electron scavenging by methyl bromide in γ-irradiated 2,2,4-trimethylpentane can be quantitatively described by an empirical model similar to that proposed for cyclohexane, $G(CH_3) = G_{fi} + G_{gi}\sqrt{\alpha CH_3Br\ [CH_3Br]}/(1 + \sqrt{\alpha CH_3Br\ [CH_3Br]})$. This model was also found to be a good description of data from other scavengers—ethyl bromide and sulfur hexafluoride—in 2,2,4-trimethylpentane. The following parameters were obtained by treating the results in this manner: $G_{fi} = 0.3$, $G_{gi} = 4.54$, $\alpha_{CH_3Br} = 24.7\ M^{-1}$, $\alpha_{SF_6} = 65\ M^{-1}$, $\alpha_{C_2H_5Br} = 5\ M^{-1}$. From the analysis of the scavenging data it is concluded that (1) the characteristic thermalization length in 2,2,4-trimethylpentane is ~50% longer than that in cyclohexane and (2) the rate constant of electron scavenging by CH_3Br as well as the constant λ, representing the recombination rate of geminate ions, are approximately ten times higher in 2,2,4-trimethylpentane than in cyclohexane. The analysis of the nitrogen yields from N_2O–2,2,4-trimethylpentane solutions allows one to estimate that the reaction of the secondary ion produced upon electron capture by N_2O proceeds at a diffusion-controlled rate. (auth)

47845 PRODUCTION OF HALIDE ION IN THE RADIOLYSIS OF AQUEOUS SOLUTIONS OF THE 5-HALOURACILS. Bansal, Krishan M.; Patterson, Larry K.; Schuler, Robert H. (Carnegie-Mellon Univ., Pittsburgh). J. Phys. Chem.; 76: No. 17, 2386-92 (17 Aug 1972).

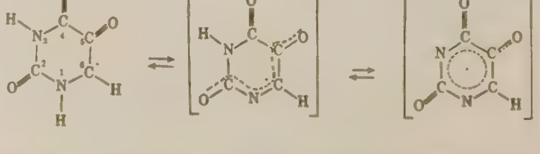
The radiation chemical production of halide ion from aqueous solutions of 5-fluoro-, 5-chloro-, and 5-bromouracil was examined by conductometric pulse radiolysis and ion-selective electrode methods. The conductometric studies indicate that on the time scale of 10^{-5} to 10^{-2} sec approximately 15, 50, and 80% of the hydrated electrons produced in the irradiation react to form F^-, Cl^-, and Br^- from the respective halouracils while attack by ·OH radicals gives hydrogen halide with corresponding efficiencies of 75, 65, and 55%. In these latter cases the yields of hydrogen halide presumably result from addition of ·OH at the 5 position followed by dehydrohalogenation of the resulting radical. About 50% of the H atoms produce Br^- from bromouracil but the contribution is small in the case of the fluoro and chloro compounds. Steady-state experiments in which the halide ion was determined after γ radiolysis show that long-term processes are responsible for significant additional yields of halide ion. In particular it is shown that each of the halouracils is subject to attack by organic radicals arising from the uracil itself or produced from other solutes present in the system. In 5-chloro- and 5-bromouracil solutions containing added isopropyl alcohol a chain mechanism leads to the production of large yields of Cl^- and Br^-. (auth)

47846 PULSE RADIOLYSIS STUDIES OF 5-HALOURACILS IN AQUEOUS SOLUTIONS. Patterson, L. K.; Bansan, K. M. (Carnegie-Mellon Univ., Pittsburgh). J. Phys. Chem.; 76: No. 17, 2392-9(17 Aug 1972).

Pulse radiolysis studies of 5-fluorouracil, 5-chlorouracil, and bromouracil were carried out in argon and N_2O-saturated aqueous systems. Rate constants for attack by e^-_{aq} and ·OH were found to be insensitive to the character of the halogen substituent. The second-order rate constant for attack on the halouracil by e^-_{aq} is $(1.4 \pm 0.2) \times 10^{10}\ M^{-1}\ sec^{-1}$ and by ·OH is $(5.4 \pm 0.2) \times 10^9\ M^{-1}\ sec^{-1}$ at pH 7. The stability of the halouracil radical anion or its protonated analog was found to be, however, markedly affected by altering the halogen at the C-5 position. Upon reaction with hydrated electrons the fluoro and chloro compounds gave similar spectra though differing in intensities (λ_{max} 335 ± 5 nm). No significant optical absorption by the bromouracil anion was observed within the time resolution of the apparatus used here. Rates of decay associated with the species produced from reaction with e^-_{aq} followed the order: bromo- ≫ chloro- > fluorouracil. The dehalogenated intermediates from bromo- and chlorouracil appeared to give hydrolysis products with λ_{max} 360 ± 5 nm. Reactions of these intermediates with tert-butyl alcohol were also indicated. Reactions with ·OH produced very similar transient spectra in all three cases with λ_{max} at 330 ± 5 nm and a broad band in the region 400 to 425 nm. Loss of a halide ion following attack at the C-5 position appeared to be very rapid in all cases with ·OH attachment as the rate-determining step. Spectra associated with H-atom reactions at pH 1 are included and show similar optical absorptions for FUr and ClUr systems (λ_{max} ~370 nm). The BrUr intermediate exhibited an additional absorption at lower wavelengths. All results are in reasonable agreement with the findings of conductometric pulse radiolysis studies on comparable systems. (auth)

47847 ELECTRON SPIN RESONANCE STUDY OF RADICALS PRODUCED IN IRRADIATED AQUEOUS SOLUTIONS OF 5-HALOURACILS. Neta, P. (Carnegie-Mellon Univ., Pittsburgh). J. Phys. Chem.; 76: No. 17, 2399-2402(17 Aug 1972).

Radicals produced in irradiated aqueous solutions of 5-halouracils were studied using the in situ radiolysis state ESR method. The radicals produced by the reaction of OH with fluoro-, chloro-, and bromouracil were found to be identical. The spectrum observed in alkaline solution shows two nitrogen splittings and one proton splitting, that in neutral solution contains two proton splittings, and the spectrum in acid solution shows three. The parameters determined from the spectra suggest these acid-base forms of the radical



These radicals are formed by addition of OH to position 5 followed by elimination of hydrogen halide. The corresponding radicals from 5-bromoorotic acid and 5-chlorobarbituric acid were also observed. The radicals produced by reactions of e^-_{aq} with 5-halouracils were not observed because they rapidly abstract a hydrogen atom from the formate used as a scavenger for OH. (auth)

47848 RADIOLYSIS OF LIQUID 2,2,4-TRIMETHYLPENTANE. EFFECT OF CHARGE SCAVENGERS ON PRODUCT FORMATION. Bansal, Krishan M.; Rzad, Stefan J. (Carnegie-Mellon Univ., Pittsburgh). J. Phys. Chem.; 76: No. 17, 2381-6(17 Aug 1972).

Electron scavengers are found to depress the hydrogen yield and have only a slight effect on the methane yield. The effects of these electron scavengers are quantitatively described by the empirical equations proposed earlier for cyclohexane. It is concluded that in 2,2,4-trimethylpentane only 30 and 5% of the ionic neutralization processes produce hydrogen and methane, respectively. Although some hydrogen atoms originate in ion recombination processes, this is not the case for methyl radicals, which originate exclusively from excited states produced directly by radiation. Methyl radicals are found to be scavenged by ethylene, and a value of 33 is obtained for the ratio of the rate constant for the addition of methyl radicals to ethylene to that for abstraction of hydrogen from the solvent. From the effect of N_2O and ND_3 on the hydrogen yield in 2,2,4-trimethylpentane, values of $\alpha_{N_2O} = 6\ M^{-1}$ and $\alpha_{ND_3} = 0.15\ M^{-1}$ are obtained. (auth)

47849 RADIOLYSIS OF WATER SOLUTIONS IN REACTOR CIRCUITS OF ATOMIC POWER STATIONS. Milaev, A. I.; Tevlin, S. A. At. Energ. (USSR); 33: No. 2, 673-6(Aug 1972). (In Russian).

Kinetics of the radiolysis of water solutions in reactor circuits of atomic power stations is considered. A mathematical model of pulse and continuous radiolysis is proposed. (auth)

47850 YIELD OF NITRITE IONS IN GAMMA-RADIOLYSIS OF URANYL NITRATE AND CALCIUM NITRATE IN TRIALKYL PHOSPHATE AND n-BUTANOL. Dziegielewski, J.; Kalecinski, J.; Jezowska-Trzebiatowska, B. (Univ., Wroclaw. Inst. of Low Temperatures and Structure Research, Wroclaw). Bull. Acad. Pol. Sci., Ser. Sci. Chim.; 20: No. 3, 285-90(1972).

It was found that the yields, $G(NO_2^-)$, increase with an increase of the initial concentration of uranyl and calcium nitrates in triethyl phosphate (TEP), trimethyl phosphate (TMP), and n-butanol. In TMP the yield of nitrite for both uranyl and calcium nitrates are nearly equal, in TEP the yields of nitrite for uranyl nitrate are significantly lower than that for calcium nitrate and in n-butanol; the yield of nitrite for uranyl nitrate is nearly zero. The experimental data allow calculation of yields of solvated electrons in the solvents examined ($G_{e^-_{solv}} = 1.2$ and 1.1 in n-butanol and trialkyl phosphates, respectively) and show that the secondary reaction plays an important role. (auth)

47851 ELECTRON PARAMAGNETIC RESONANCE OF FREE RADICALS IN AN ADAMANTANE MATRIX. IV. THE STRUCTURE OF THE tert-BUTYL RADICAL. Wood, David E. (Univ. of Connecticut, Storrs); Williams, Lawrence F.; Sprecher, Richard F.; Lathan, William A. J. Amer. Chem. Soc.; 94: No. 17, 6241-3(23 Aug 1972).

An EPR study was made of the isotopically substituted radical 1,1-dimethylethyl-1-^{13}C-d_9, which was prepared by x irradiation of the chloride in adamantane-d_{16}. Experimental evidence suggests that the tert-butyl radical was a nonplanar equilibrium geometry. An estimate of the bond angle in the tert-butyl radical using Coulson's method gave a value of 117.3°. INDO and molecular orbit calculations were also used to investigate the structure of the tert-butyl radical. (D.H.M.)

47852 STRUCTURE AND REACTIVITY OF ORGANIC IONS IN GAS-PHASE RADIOLYSIS. VI. THE FORMATION PROCESS OF THE $C_7H_7^+$ ION FROM ETHYLBENZENE AND THE REACTION WITH DIMETHYLAMINE. Takamuku, Setsuo; Sagi, Nobuo; Nagaoka, Kenji; Sakurai, Hiroshi (Osaka Univ.). J. Amer. Chem. Soc.; 94: No. 17, 6217-18(23 Aug 1972).

In order to study the structure and the formation process of the $C_7H_7^+$ ion, which has been attributed to be a troplium ion rather than a benzyl ion in the area of spectrometry, the reaction of $C_7H_7^+$ ion with dimethylamine was investigated using ethylbenzene and ethylbenzene-α-d_2 for a scrambling study. The radiolysis of gaseous mixtures of ethylbenzene and dimethylamine resulted in the formation of N,N-dimethylbenzylamine and a small amount of an unknown product along with the usual products of the radiolysis of ethylbenzene (toluene, benzene, and ethyldiphenylmethane). N,N-dimethyltropylamine, which would be expected to be formed by the reaction of tropylium ion with dimethylamine, was not detected among the reaction products. (D.H.M.)

47853 ELECTRON SPIN RESONANCE, OPTICAL, AND THEORETICAL STUDIES OF THE RADICAL ANION OF SULFURYL CHLORIDE. Kerr, Carolyn M. L.; Williams, Ffrancon (Univ. of Tennessee, Knoxville). Contract AT(40-1-)-2968. J. Amer. Chem. Soc.; 94: No. 15, 5212-21(26 Jul 1972). (ORO-2968-70).

$SO_2Cl_2^{-\cdot}$ is the only observable product of electron attachment in γ-irradiated crystalline sulfuryl chloride at $-196°C$. By contrast, $SO_2Cl_2^{-\cdot}$, $Cl_2^{-\cdot}$, and $SO_2^{-\cdot}$ were identified by their ESR spectra in γ-irradiated glassy solutions of sulfuryl chloride. The three species are readily distinguished by selective photobleaching, and this was utilized in assigning an absorption band at 432 nm (λ_{max}) to $SO_2Cl_2^{-\cdot}$. A similar absorption band is observed at 415 nm in crystalline sulfuryl chloride. The ESR parameters of $SO_2Cl_2^{-\cdot}$ in the glasses, $A_{||}(^{35}Cl) = 62.4-62.9$ G and $g_{||} = 2.0058-2.0060$, are close to the corresponding values (64.1 G and 2.0055) determined in polycrystalline sulfuryl chloride. Although the perpendicular features are not well defined in the powder spectra, the large anisotropy of the chlorine hyperfine splitting was demonstrated by use of an aligned crystalline sample. The calculated spin density in the chlorine p orbitals is incompatible with the structures proposed for other 33-valence electron radicals and a novel structure was proposed for $SO_2Cl_2^{-\cdot}$. The unpaired electron is visualized as occupying a supramolecular orbital comprising the lowest unoccupied orbitals of essentially separate SO_2 and Cl_2 molecules. Iterative extended Hückel calculations support this model and yield, in addition, electron spin density distributions for the radical similar to that found experimentally. (auth)

47854 SUBNANOSECOND PULSE RADIOLYSIS STUDIES. Wallace, Stephen Charles. Vancouver, B. C.; Univ. of British Columbia (1971). National Library of Canada, Ottawa. Thesis.

Pulse radiolysis investigations were made on very early physicochemical and chemical events in the radiation chemistry of polar liquids, in particular liquid water, where transient absorptions due to the hydrated electron were observed with lifetimes as short as ~30 picoseconds. These studies were carried out using the novel technique of Cherenkov reabsorption spectroscopy, which in conjunction with an extremely high dose-rate electron accelerator (peak dose-rate = 1.8×10^{28} eV cm^{-2} sec^{-1}) yields information pertaining to subnanosecond radiation chemical events from measurements made with existing nanosecond technology. A critical evaluation of all experimental aspects of this newly developed technique, as well as a partial theoretical analysis of the relationships between physical parameters and experimental observables, were both performed in order to establish the validity of such pulse radiolysis studies. Kinetic effects in molar concentrations of hydrated electron scavengers and relative solvated electron yields in water and the alcohols were interpreted to suggest that the time-scale of charge neutralization in radiation chemistry is very much shorter than previously proposed, thus necessitating a modification of the existing description of subnanosecond events as contained in the spur diffusion model for radiation chemical yields. The primary reducing species of the radiolysis of formamide, a liquid of very high dielectric constant, was postulated as a negative ion, rather than a solvated electron; this negative ion being formed directly by solvent scavenging of thermalized electrons. With the availability of new spectral data for solvated electrons from this and other work, a revival of the earlier suggested spectral correlation with iodide ion C.T.T.S. spectra is proposed, with many of the earlier discrepancies now removed. Because absorption spectra are deduced from light emission measurements in the Cherenkov reabsorption technique, an added feature of this work was the possible observation of radioinduced molecular luminescence from liquid water; however over the spectral range 200 to 850 nm the limiting 100 eV yield of such luminescence was $\leq 10^{-3}$ with a lifetime ≤ 2 nanoseconds. (Diss. Abstr. Int., B)

47855 EFFECT OF ELECTRIC FIELD STRENGTH ON THE FREE ION YIELDS IN THE X-RADIOLYSIS OF LIQUIDS: INFLUENCE OF MOLECULAR STRUCTURE AND TEMPERATURE. Dodelet, J.-P.; Fuochi, P. G.; Freeman, G. R. (Univ. of Alberta, Edmonton). Can. J. Chem.; 50: No. 11, 1617-26(1 Jun 1972).

The relative increase in free ion yield with increasing field strength E, expressed as G_{fi}^{E}/G_{fi}^{0}, was smaller when the following quantities were larger: (1) dielectric constant, (2) temperature, and (3) separation distance between the germinate ion–electron pairs. The field dependence $(dG_{fi}^{E}/dE)/G_{fi}^{0}$ equals $9.7/\epsilon T^2$ cm/V at low E, but at higher fields it is affected by the above three factors and by E itself. Results obtained from the liquids propane (123 to 233°K), 2-methylpropane (isobutane, 148 to 294°K), 2,2-dimethylpropane (neopentane, 295°K), argon (87°K), oxygen (87°K) and argon–oxygen solutions (87°K) are presented and analyzed according to a theoretical model. Several types of ion–electron separation (y) distribution functions were tested. Within the framework of the model a power function $F(>y) = y_{min}\ y^{-x}$ with $x < 4$ provides a good interpretation of the results when $G_{fi}^{0} <$

0.2; a Gaussian distribution function provides the best interpretation of the field effects when $G_{fi}^{0} > 0.2$. Either the y distribution has a Gaussian core with a more gently sloping tail, or distributions are more Gaussian-like in liquids in which the electron ranges are greater. The electron range in pure argon (b = 1300 Å) is much smaller than was expected and is only 2.6 times greater than that in liquid methane (b = 500 Å at 120°K). Phonon emission by 10 to 0.01 eV electrons in liquid argon may be relatively efficient and might involve transient states of the type Ar_2^*. (auth) (Canada)

47856 STUDIES IN RADIATION CHEMISTRY. Shaede, Eric Albert. Vancouver, B. C.; Univ. of British Columbia (1971). National Library of Canada, Ottawa.
Thesis.

The reaction of hydrated electrons with molecular nitrogen is reported. Results of an investigation of the effects of γ radiation on the polar aprotic solvent, propylene carbonate in the glassy solid state at 77°K and as a liquid at room temperature are presented. Hydrated electrons were generated by γ radiolysis of aqueous solutions containing H_2 and OH^- and also containing N_2 at concentrations up to 0.1 M (200 atm pressure). Significant yields of ammonia were obtained, but by completely eliminating the gas space above the solution it was shown that the majority of the NH_3 arose through "direct action" of the radiation on dissolved N_2. Although the hydrated electron is one of the most powerful and reactive reducing agents, it is unable to cause reduction fixation of molecular nitrogen. An upper limit $k_1 < 18\ M^{-1}s^{-1}$ was estimated for the rate constant of the reduction reaction. Conversion of the hydrated electrons to H atoms in acid solution did not affect the ammonia yield, implying that H atoms are also unable to reduce nitrogen. In the glassy solid state at 77°K, γ irradiation of propylene carbonate produced species identified as trapped electrons. They were characterized by a narrow (ΔH_{ms} = 4.5 G), Gaussian shaped ESR line at g = 2.0028 and an optical absorption band with λ_{max} ~370 nm. The electrons were unstable at 77°K and decayed via a nonhomogeneous process believed to be reaction with positive ions. Also formed by the γ radiation were four unidentified trapped radicals, all characterized by doublet ESR signals centered at g = 2.0023 and with hyperfine splittings of 42, 58, 83, and 124 G. Ultraviolet photolysis of the irradiated glasses at 77°K produced new radicals identified as CO_3^-, HCO, and CH_3. The CO_3^- radical gave a single ESR line at g ~2.015 and a broad visible optical absorption band with λ_{max} ~600 nm. HCO was identified by its asymmetric doublet ESR signal with hyperfine splitting of about 130 G and a multi-line vibronic absorption spectrum in the 500 to 750 nm region. The methyl radicals were unstable in the matrix and were identified by their characteristic 1:3:3:1 quartet ESR spectrum with hyperfine splitting of about 21 G. Gamma radiolysis of liquid propylene carbonate at 25°C produced H_2, CO, and CO_2 as the major gaseous "molecular" products with yields: $G_{H_2} = 0.75 \pm 0.05$, $G_{CO} = 1.2 \pm 0.1$, and $G_{CO_2} = 3.2 \pm 0.3$. Methane was also produced via a secondary process involving methyl radicals with a yield: $G(CH_4) = 0.20 \pm 0.02$. Scavenger experiments with N_2O, I_2, methanol, and acid indicated that an anionic reducing species was formed by the radiation with a yield of $G_{X^-} = 2.0 \pm 0.2$. This species was probably a solvated electron although the possibility of it being a reactive molecular anion could not be excluded on the basis of steady-state radiolysis data. A transient optical absorption at 630 nm was observed on pulse radiolysis of propylene carbonate with 3 nsec pulses of 0.5 MeV electrons. However, either solvated electrons or the CO_3^- radical ion could have been responsible for the absorbance. (Diss. Abstr., Int., B)

47857 SEARCH FOR THE N–N_2 EXCHANGE REACTION. Lyon, R. K. (ESSO Research and Engineering Co., Linden, N. J.). Can. J. Chem.; 50: No. 9, 1437-40(1 May 1972).

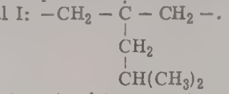
Since N_3 is a stable molecule, one might expect the N-N_2 exchange reaction to occur readily. Accordingly, experiments were performed in which a $N^{14}{\equiv}N^{14}/N^{15}{\equiv}N^{15}$ mixture was irradiated with gamma radiation from ^{60}Co at temperatures from ambient to 1000°C for periods of about 100 hr. The rate of formation of $N^{14}{\equiv}N^{15}$ was measured with a mass spectrometer and found to be independent of temperature. Hence, the chain reaction, if it occurs at all, must be very slow, with a rate constant $\leq 8 \times 10^6$ cc/mol · s at 1000°C. An explanation in terms of conservation of spin is discussed. (Canada)

47858 RADIATION-INDUCED OXIDATION OF 2-PROPANOL BY NITROUS OXIDE IN ALKALINE AQUEOUS SOLUTION. Burchill, C. E.; Wollner, G. P. (Manitoba Univ., Winnipeg, Can.). Can. J. Chem.; 50: No. 11, 1751-6(1 Jun 1972).

The gamma-induced oxidation of 2-propanol to acetone by N_2O in alkaline aqueous solution proceeds via a free radical chain mechanism independent of pH above 12.5. The results are explained by abstraction of H from 2-propanol by O^- at both the α and β-positions (85% α attack). Chain propagation is by reaction of the α radical anion, $(CH_3)_2\dot{C}O^-$, with N_2O with a rate constant of $(3.8 \pm 0.4) \times 10^4\ M^{-1}\ s^{-1}$, and by reaction of the β radical, $\dot{C}H_2(CH_3)CHOH$, with 2-propanol to give the α radical with a rate constant of $430 \pm 30\ M^{-1}\ s^{-1}$. The conclusions are supported by demonstration of kinetic isotope effects for selectively deuterated alcohols. (auth) (Canada).

47859 ESR OF RADICAL PAIRS IN IRRADIATED TPX POLYMER. Charles, M. W. (St. Bartholomew's Hospital Medical Coll., London). J. Polym. Sci., Part A-2; 10: No. 8, 1609-10(Aug 1972).

An ESR study of radiation damage in poly-4-methyl-1-pentene is reported. Air-free samples irradiated with electrons gave rise to an eight-line spectrum consistent with the formation of a species called radical I:



$$-CH_2-\underset{\substack{|\\CH_2\\|\\CH(CH_3)_2}}{\dot{C}}-CH_2-.$$

If the sample is raised to room temperature for a few minutes and then returned to 77°K a similar spectrum is obtained, except that the lines are narrower and more structure is observed. This spectrum is also attributed to radical I and the difference in the spectra is mainly due to broadening by dipole-dipole interaction. (D.H.M.)

Radiochemistry and Nuclear Chemistry

Refer also to abstracts 47737, 48308, 49306, and 50022.

47860 (BNWL-CC-1374) IMPREGNATION OF GRAPHITE WITH NEPTUNIUM OXIDE. Fullam, H. T.; Mitchell, C. J. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). 16 Oct 1967. Contract AT(45-1)-1830. 15p. Dep. NTIS.

A total of eight graphite pieces were impregnated with neptunium oxide for use as target elements in experimental ^{238}Pu production. The neptunium content of each element varied from 37.1 to 41.4 g with a total of 316.4 g of neptunium in the eight elements. The impregnation process consisted of soaking the graphite element (TSF grade graphite) in neptunium nitrate solution to fill the voids, drying the element to remove the excess water, and then calcining at 1000°C under an argon atmosphere to convert the neptunium to the oxide. The entire cycle required approximately sixteen hours, and four to five cycles were required to reach the desired neptunium concentration of 40 g per element. The composition and physical characteristics of NpO_2-impregnated elements are given. (auth)

47861 (UCRL-Trans-1461) PREPARATION OF COLLOIDAL ^{198}Au. Douis, M. Translated by H. G. Parker (Univ. of California, Lawrence Berkeley Lab., Berkeley), from Minerva Nucl.; 7: No. 11, 448-50(1963). 8p. Dep. NTIS.

Reference is made to the principle on which the method of preparing radioactive colloidal gold is based and the technical details of the method, as well as the characteristics of the gold obtained are illustrated schematically. Mention is made to tests carried out on all radioactive colloid preparations destined for medical use. (The study was originally reported as NSA 18: 10083.) (auth)

47862 METHOD FOR PREPARING NAD LABELED WITH ^3H OF HIGH SPECIFIC RADIOACTIVITY IN THE 4-NICOTINAMIDE POSITION. Little, John W. (National Institutes of Health, Bethesda, Md.). Anal. Biochem.; 48: No. 1, 217-24 (Jul 1972).

A scheme is given for the rapid preparation of NAD specifically labeled at a very high specific radioactivity with ^3H at the 4-position of the nicotinamide ring. (auth)

47863 NEW RADIOACTIVE DRUGS. THE PREPARATION OF ^{99m}Tc- AND ^{113m}In-LABELED COMPOUNDS. Ogawa, Hiroshi (Daiichi Radioisotope Labs., Ltd., Tokyo). Sogo Rinsho; 20: No. 8, 1765-71(Aug 1971). (In Japanese).

Pertechnetate (^{99m}Tc-labeled) is formed by dissolving a ^{99}Mo–^{99m}Tc generator in a physiological solution. The preparations for the main compounds of ^{99m}Tc, i.e., $^{99m}Tc_2S_7$ colloid, $^{99m}TcO_2$ colloid, ^{99m}Tc-antimony sulfide colloid, ^{99}Tc-1-serum albumin, ^{99m}Tc-MAA (^{99}Tc-macroaggregated albumin), ^{99m}Tc-Fe ascorbic acid complex, ^{99m}Tc-Fe citrate complex, ^{99m}Tc-iron hydroxide aggregates, ^{99m}Tc-macroaggregated thionin, ^{99m}Tc-microaggregated albumin, ^{99m}Tc-cystin, ^{99m}Tc-methionin, ^{99m}Tc-tagged serum, ^{99m}Tc-microspheres, ^{99m}Tc-aggregated albumin, and ^{99m}Tc-ETPA, are described. Indium-113m can be obtained by dissolving a ^{113}Sn– ^{113}In generator in hydrochloric acid solution.

The preparation of some ^{113}In-labeled compounds, i.e., ^{113}In-colloid, ^{113}In-DTPA, ^{113m}In-MAA, and ^{113}In-Microsphere is described. (auth)

47864 50th ANNIVERSARY OF THE V. G. KHLOPIN INSTITUTE OF RADIUM. At. Energ. (USSR); 33: No. 2, 611-16(Aug 1972). (In Russian).

A collection of nine review articles was published jointly in recognition of the 50th anniversary of the Khlopin Institute of Radium. B. P. Nikolski discussed radiochemical investigations at the Institute. V. I. Paramonova, V. I. Grebenshchikova, and M. F. Pushlenkov presented the Institute's work on ion exchange, coprecipitation processes, and extraction research, respectively. The field of nuclear physics is amply represented by papers on the growth of nuclear physics, fission of heavy nuclei, and nuclear reactions at low and medium energies, by N. A. Perfilov, K. A. Petrzhak, and Yu. A. Nemilov, respectively. L. V. Komlev reports on geochemical research at the Institute and the final paper by L. I. Gegeonov is concerned with environmental radioactivity. (K.S.W.)

Hot-Atom Chemistry

Refer also to abstract 47818.

47865 (FRNC-TH-185) CHEMICAL BEHAVIOR OF ^{130m}I AND ^{130}I PRODUCED IN GASEOUS IODINE-BUTANE MIXTURES BY THE NUCLEAR REACTIONS: ^{129}I(n,γ)^{130m}I AND ^{129}I(n,γ)^{130}I. Behzadi, Cambyse (Strasbourg Univ. (France)). 1972. 63p. (In French). Dep. NTIS (U.S. Sales Only).

The activities (in the form of organic iodides) of ^{130m}I formed by the (n,γ) reaction and ^{130}I formed by the (n,γ) reaction and isomeric transition were compared with the total activity of these radioelements. The changes in the organic yield were studied as a function of sample compositions (iodine, butane, rare gas) in view of determining the nature of the reactions. Descriptions are given of the preparation of the reagents, the gas mixtures, neutron irradiation, determination of the total activity of the iodine, radiochromatographic analysis of the iodides, and measurements of their activities. If the consequences of radiolysis by reactor radiation are not considered, as they are independent of the (n,γ) process, the organic iodides can be considered to be formed by two types of mechanism. Radical mechanisms are observed in the autoirradiation zone produced by the emission of various different low-energy radiations during the de-excitation of the ^{130}I compound nucleus. This phenomenon becomes insignificant for large I_2 molar fractions, the iodides arising from ion-molecule reactions indicating the existence of the I^+ ion in the $^1D_2$ and $^1S_0$ states. It was thus possible to establish that hot mechanisms participate very little in processes involving nondissociated I_2 molecules. No isotopic effects were observed. (France)

47866 (JUL-832-RC) SOLID-STATE REACTIONS OF HALOGEN RECOIL ATOMS IN HEXAHALOGEN COMPLEXES OF SEVERAL TRANSITION METALS. Otterbach, J. (Kernforschungsanlage, Juelich (West Germany). Institut fuer Radiochemie). Mar 1972. 94p. (In German). Dep. NTIS (U. S. Sales Only).

Thesis. Submitted to Cologne Univ. (West Germany).

Solid-state reactions produced by ^{38}Cl and ^{82}Br recoil atoms resulting from (n,γ) reactions in $K_2(ReBr_6)-K_2(ReCl_6)$ ‡ mixed crystal systems were studied. By means of fast electrophoretic and chromatographic separation procedures in combination with γ spectrometry, distribution of products labeled with ^{38}Cl and ^{82}Br was measured. Dependency of product yield on composition of the mixed crystals permitted a kinetic analysis of hot reactions. The yield curves could be described mathematically by functions that indicated three different fundamental mechanisms: primary retention, collision substitution, and a three-step process. (140 references) (H.B.G.)

47867 REACTIONS OF ^{80}Br ACTIVATED BY THE (n,γ) PROCESS WITH METHANE. Saeki, Masakatsu; Numakura, Kenshi; Tachikawa, Enzo (Japan Atomic Energy Research Inst., Tokai). Bull. Chem. Soc. Jap.; 45: No. 6, 1715-19(Jun 1972).

The reactions of ^{80}Br activated by the (n,γ) process with CH_4 were examined. By assuming that the limiting yields of products at 1.0 multifold of the Kr-moderator is due to thermal ionic processes, the kinetic yields were tentatively determined to be the 12.4% for total organic, 11.4% for $CH_3{}^{80}Br$, and 1.0% for $CH_2{}^{80}BrBr$. A similar treatment of results from the reactions with CD_4 gives 5.1% for total organic, 3.9% for $CD_3{}^{80}Br$, and 1.2% for $CD_2{}^{80}BrBr$. When the $CH_3{}^{80}Br$ yield was compared with that from the reactions of ^{80}Br from isomeric transition activation, a noticeable difference was noticed; it was roughly 3 times as large as in the latter system. Furthermore, the pressure effects on $CH_3{}^{80}Br$ show that a fraction of $CH_3{}^{80}Br$ is highly excited and is able to decompose even at a pressure of 1920 mmHg. This suggests that the distribution of ^{80}Br is highly excited and is able to decompose even at a pressure of 1920 mmHg. This suggests that the distribution of ^{80}Br in the reaction energy range extends to a higher energy than in the case of ^{80}Br activated by the isomeric transition process. (auth)

47868 CHEMISTRY OF ATOMIC SILICON. III. REACTIONS OF ELECTRON BOMBARDMENT PRODUCED SILICON VAPOR WITH SILANES. Skell, Philip S.; Owen, Peter W. (Pennsylvania State Univ., University Park). J. Amer. Chem. Soc.; 94: No. 15, 5434-8(26 Jul 1972).

Silicon atoms were found to react with trimethylsilane, dimethylsilane, methylsilane, and disilane exclusively by insertion into silicon-hydrogen bonds. The resulting silenes inserted into a silicon-hydrogen bond of another substrate molecule, or polymerized to form linear and cyclic polysilanes. The electron bombardment of solid-phase silanes at 77°K gave products derived from silene intermediates. (auth)

47869 THERMAL NEUTRON IRRADIATION OF n-BUTYL BROMIDE. Ronneau, C.; Cara, J.; Apers, D.; Capron, P. (Univ., Louvain, Belgium). Radiochim. Acta; 17: No. 1, 33-7(May 1972).

Experiments were performed in order to analyze the possible fate of recoil bromine atoms in n-butyl bromide media. The effects of low temperature irradiations and of low temperature storage were examined. Radical reactions were studied by using different radical scavengers. Results indicate that bromine shows a different behavior, depending on whether its recoil is due to a (n,γ) reaction or to an isomeric transition. (auth)

47870 CHEMICAL EFFECTS ASSOCIATED WITH NEUTRON CAPTURE IN COBALT PHTHALOCYANINE. Endo, Kazutoyo; Sakanoue, Masanobu (Kanazawa Univ., Japan). Radiochim. Acta; 17: No. 1, 7-11(May 1972).

The chemical behavior of recoil cobalt atoms after neutron capture events was investigated in α- and β-cobalt phthalocyanines. The initial retention values in β-crystals were affected by the duration of the neutron irradiation even at dry-ice temperature. The effect was found to be exponentially dependent on irradiation time. On the other hand, the α-crystals were observed to be stable for irradiation. The comparison of data on both crystals could make it possible to estimate the contribution of the hot process in a hot zone in irradiated cobalt phthalocyanine. (auth)

47871 RECOIL REACTIONS OF ^{13}N IN SIMPLE INORGANIC COMPOUNDS. Aten, A. H. W. Jr.; Kapteyn, J. C. (Instituut voor Kernphysisch Onderzoek, Amsterdam). Radiochim. Acta; 17: No. 1, 59-60(May 1972).

Reactions of recoil ^{13}N in neutron-irradiated and unannealed and annealed $NaNO_3$, $NaNO_2$, NaCN, and NaCNS were studied. For $NaNO_3$, $NaNO_2$, and NaCN, annealing at moderate temperatures caused little or no change in the activity distribution. Almost all of the ^{13}N was found in chemical fractions that may have been formed within the matrix itself. Thiocyanate was an exception in both cases. (M.C.G.)

47872 CHEMICAL EFFECTS OF THE ^{129}I(n,γ)^{130m,130}I REACTION IN THE PRESENCE OF BUTANE. Behzadi, C.; Kuhry, J. G.; Heitz, Ch. (Univ. Louis Pasteur, Strasbourg). Radiochem. Radioanal. Lett.; 11: No. 1, 19-28(31 Jul 1972). (In French).

The organic yields of iodine from the ^{129}I(n,γ)^{130m,130}I reaction in gaseous iodine-butane mixtures were measured. The effects of the mole fraction of iodine and of the rare gases were studied. The results suggest that mostly thermal processes are involved in the formation of the organic iodides. (auth)

47873 UNIMOLECULAR PROCESSES SUBSEQUENT TO RECOIL TRITIUM REACTIONS WITH SPIROPENTANE. Su, Y. Y.; Tang, Yi-noo (Texas A and M Coll., College Station). J. Phys. Chem.; 76: No. 16, 2187-95(3 Aug 1972).

Spiropentane-t molecules, excited by the T*-for-H substitution, underwent unimolecular processes by two different routes: one is direct decomposition to C_2H_3T and allene-t while the other is a consecutive isomerization-decomposition reaction, which proceeds through its isomer, methylenecyclobutane, to give the same end products. The unimolecular nature of the decomposition was verified by pressure studies from 100 to 1500 Torr. The C_3H_3T/C_2H_3T ratios from these samples were all approximately equal to 1.0. According to the reaction mechanism, this means the RRKM postulate of energy randomization before decomposition is a useful approximation for the recoil tritium excited systems at the employed pressure range. (auth)

Properties of Radioactive Materials

Refer also to abstracts 47738, 47740, 47742, 47759, 47772, 47842, 48038, 48345, and 48346.

47874 (COO-3105-2) TRITIUM LABELING OF POLYPEPTIDE HORMONES—ADRENOCORTICOTROPIN (ACTH). Hembree, W.; Zimmering, P. E.; Wolf, A. P. (Columbia Univ., New York. Coll. of Physicians and Surgeons. Brookhaven National Lab., Upton, N. Y.). [nd]. 6p. (CONF-710654—1). Dep. NTIS.

From Endocrine Society meeting; San Francisco, CA. (Jun 1971).

Tritiated ACTH was prepared with a range of activities from 0.1 to 4.0 mCi/mg by the method of microwave activation of tritium exchange. This method gave a 1000-fold greater specific activity than that obtained by Wilzbach labeling of ACTH. No loss of biologic activity was associated with the tritium labeling. (M.C.G.)

47875 (INIS-mf-193) KINETICS AND MECHANISM OF HYDROGEN REDUCTION OF SOME URANIUM OXIDES. Juusela, J. (Helsinki Univ. of Technology, Otaniemi (Finland). Lab. of Process Metallurgy). 1971. 53p. INIS.

Thesis.

Hydrogen reductions were carried out on two types of U_3O_8 powders and four powder fractions. Kinetics and mechanisms of solid U_3O_8 and UO_2 reactions were studied. A method was developed to produce dense bodies of U_3O_8 with high oxygen content (O/U = 2.65). Activation energies for powders (Q_{active} = 32 kcal/mole, and $Q_{inactive}$ = 28 kcal/mole) were determined and they were related to the reduction of the UO_2^+ phase because of fast nucleation rates in powders. The following conclusions were made: (a) the parabolic law found with active U_3O_8 cannot be used as any indication of the mechanism, (b) the rate of reaction with powder fractions and inactive U_3O_8 was found to obey a linear law, (c) a linear relationship between specific surface areas and rate constants was determined for the fractions ($k_f^1 = 0.096 \cdot S + 0.33$), (d) the rate of reaction per unit area was greater with inactive U_3O_8 than with active due to different values of p_{H_2} inside the samples caused by different surface characteristics of powders, (e) reduction of solid U_3O_8 was found to obey the Avrami—Erofeev equation (α = fraction reacted = $1\text{-}c^{-kn}$) with the value $n \approx 3$, (f) at the beginning of the solid U_3O_8 reduction a linear law was found, and it was related to the nucleation and undisturbed growth of nuclei, (g) reduction of solid U_3O_8 proceeded through the formation of a UO_2 phase on initial and crack-generated surfaces. An activation energy of Q = 16 kcal/mole was found for the linear part, and Q = 22 kcal/mole for the rest of the reaction. The former indicates the nucleation and the growth of nuclei and the latter a mixed control of nucleation and reduction of the UO_2 phase. This was verified by the formation of $UO_{2.22}$ and the rapid reduction of it compared to whole reduction time on the initial surface of the sample, (h) in the reduction of UO_2 (O/U = 2.22) a diffusion-controlled reaction was found with 100% hydrogen composition, the activation energy of which was Q = 30 kcal/mole. Temperature dependence of diffusion coefficient was, for the range T = 812 to 920°C, $D = 0.15 \exp(-30000/RT)$ cm²/s, and (i) parabolic rate laws were also found with lower partial pressures of hydrogen, in reduction of solid $UO_{2.22}$, but the decrease of reaction rate with decreasing hydrogen pressure indicated the rate limiting step to be the surface phenomena. (auth) (INIS)

47876 (MLM-1907) RADIOACTIVE SERIES DECAY PROGRAM. Campbell, Allen R. (Mound Lab., Miamisburg, Ohio). 16 Aug 1972. Contract AT-33-1-Gen-53. 11p. Dep. NTIS.

This is a program for the Hewlett Packard model HP 9100B desk calculator which, using the Bateman equation, evaluates the atom ratio of n^{th} daughter ($n \leq 13$) to the progenitor of the radioactive series of a given time. (auth)

47877 (MLM-1933) VALENCE STATE DISTRIBUTIONS OF URANIUM, NEPTUNIUM, AND PLUTONIUM IN ACID SOLUTIONS. Silver, G. L. (Mound Lab., Miamisburg, Ohio). 31 Jul 1972. Contract AT-33-1-GEN-53. 58p. Dep. NTIS.

Mathematical approaches developed for the study of plutonium disproportionation reactions appear to be adaptable to the study of the distribution of the valencies of uranium and neptunium in aqueous solutions. Valence state distributions of uranium and neptunium for various conditions of solution acidity and oxidation-reduction potential are presented in tabular form. A small computer program for estimation of valence state distributions is presented, and a "solubility product" of tetravalent plutonium polymer is suggested. The Nernst Equation is used to suggest a maximum in the concentration of soluble pentavalent plutonium when the hydrous oxides of tetravalent and hexavalent plutonium are in equilibrium. (auth)

47878 (NP-19254) MOLTEN SALT BREEDER REACTOR CONCEPT. Quarterly Report for the Period Ending January 31, 1972. (Bhabha Atomic Research Centre, Bombay (India)). 9p. Dep. NTIS (U. S. Sales Only).

The solubility of PuF_3 in the binary mixture $LiF-ThF_4$ (65, 35 mole %) and the ternary mixture $LiF-BeF_2-ThF_4$ (75, 5, 20 mole %) was completed. The solubility values were found to vary between 4.62 and 6.86 mole % in the temperature range from 662 to 753°C for the binary mixture and 2.10 to 4.93 mole % for the ternary mixture in the temperature range of 553 to 710°C. The solubility of PuF_3 was determined so far in a total of four compositions of the binary mixture and five compositions of the ternary mixture. The experiments confirmed the trend in solubility values reported earlier. (auth)

47879 (UCRL-Trans-1458) NEW METHOD OF PREPARATION OF RADIOACTIVE COLLOIDAL GOLD. Henry, R.; Herczeg, C.; Fisher, C. Translated by H. G. Parker (Univ. of California, Lawrence Radiation Lab.), from Int. J. Appl. Radiat. Isotop.; 2: 136-9(1957). 8p. Dep. NTIS.

A method is described for preparation of radioactive colloidal gold with as uniform as possible a distribution of particle size. So that the two phases of precipitation and growth of the seeds will take place successively, a nonradioactive seed colloid is used for the reduction and precipitation of gold from chloramic acid. The average size of the particles obtained is 300 Å. This paper was previously abstracted from the original language and the abstract appeared as NSA 11: 13261. (M.C.G.)

47880 (UJV-2809-MA) INVESTIGATION OF THE CHEMISTRY OF U(VI) SOLIDIFICATION PROCESSES AND PROPERTIES OF THE PRODUCT OBTAINED. Baran, V.; Stamberg, K.; Tympl, M.; Urbanek, V. (Ceskoslovenska Akademie Ved, Rez. Ustav Jaderneho Vyzkumu). 1972. 80p. (In Czech). Dep. NTIS (U. S. Sales Only).

Results are described of an investigation of the U(VI) inner solidification process as a part of the ceramic fuel preparation by the sol-gel method. Phase diagrams were constructed with the following parameters: uranyl nitrate (UN)—urea (M)—urotropine (hexamethylenetetramine, H) at −5°C, room temperature and 90°C; the water content was considered approximately constant and, therefore, omitted. From these diagrams in the rearranged form with H/U and M/U, such a composition of the feed solution can be found which does not solidify up to 30 min. (at −5°C or room temperature) but after elevation of the temperature (to room or 90°C) solidification occurs in seconds or minutes. (D.H.M.)

47881 FLUORINATION OF URANIUM METAL BY FLUORINE GAS. Yahata, Taneaki; Iwasaki, Matae (Japan Atomic Energy Research Inst., Tokai). J. Nucl. Sci. Technol. (Tokyo); 9: No. 6, 353-6(Jun 1972).

A study was made on the fluorination of uranium metal chips to UF_6 with fluorine gas in the temperature range of 100 to 400°C. The formation of UF_6 was influenced by the concentration and the flow rate of fluorine gas and by the reaction temperature. The reaction occurred apparently above 200°C. Uranium metal was first converted to a low-fluorine-content compound such as UF_3 or UF_{4-x}, then to UF_4 and finally to UF_6. The intermediate compounds were confirmed by x-ray analysis and by their color. (auth)

47882 TOTAL SYNTHESIS OF $[\alpha,\gamma\text{-}^{14}C_2]$UROPORPHYRIN III. Franck, Burchard; Gantz, Dietrich; Hueper, Fritz (Univ., Muenster, Ger.). Angew. Chem. Int. Ed. Engl.; 11: No. 5, 420-1 (May 1972).

A procedure is described for total synthesis of carbon-14-labeled $[\alpha,\gamma]$uroporphyrin as its octamethyl ester. The radioactivity is introduced in the last stage of a convergent synthesis. (M.C.G.)

47883 STABILITY OF Mn(II), Co(II), Ni(II), Cu(II), Zn(II), Cd(II), AND UO_2(II) CHELATES OF N-SALICYLIDENE—β—ALANINE. Mehta, R. K.; Singhi, V. C. (Univ. of Jodhpur, India). Indian J. Chem.; 10: No. 2, 233-4(Feb 1972).

Acid dissociation constants of N-salicylidene-β-alanine (H_2S-β-A) and stability constants of its metal chelates with Mn(II), Co(II), Ni(II), Cu(II), Zn(II), Cd(II), and UO_2(II) were determined in aqueous solution of ionic strength 0.1M ($NaClO_4$) at 30 ± 0.1°C by the Calvin—Bjerrum pH-titration technique. The formation of 1 : 1 metal chelates is indicated in all the cases. The stabilities of the chelates follow the order $UO_2 > Cu > Ni > Zn > Co > Mn > Cd$, in agreement with the Irving and Williams order. The ΔF values were also calculated. (auth)

47884 STABILITY CONSTANTS OF α-MERCAPTOPROPIONIC ACID COMPLEXES WITH SOME METAL IONS. Srivastava, S. K.; Srivastava, P. C.; Nigam, H. L. (Univ. of Allahabad, India). Indian J. Chem.; 10: No. 2, 223-4(Feb 1972).

Successive stability constants of 1 : 1 complexes of Cu(II), Co(II), and Hg(II) and of 1 : 2 complexes of Ni(II), Zn(II), Pd(II), Fe(III), UO_2(VI), Zr(IV), and Th(IV) with mercaptosuccinic acid were determined potentiometrically. In the case of Pd(II), Ni(II), and Zn(II) the values of stability constants follow the well-established order Pd > Ni > Zn. However, in the Cu(II), Co(II), and Ni(II), there is a deviation and the value for Cu(II) complex is unexpectedly low. This may be due to the reduction of Cu(II) by sulfydryl (SH) group. (auth)

47885 NEUTRON DIFFRACTION STUDY OF MONOAQUOTETRAUREADIOXOURANIUM(VI) NITRATE. **Dalley, N. K.; Mueller, M. H.; Simonsen, S. H. (Argonne National Lab., Ill.). Inorg. Chem.; 11: No. 8, 1840-5(Aug 1972).**

The crystal structure of $\{UO_2(H_2O)[CO(NH_2)_2]_4\}(NO_3)_2$ was determined by neutron diffraction. The compound is monoclinic with a = 9.99 (2), b = 14.99 (3), c = 13.18 (3) Å, β = 100.08 (3)°, and space group $P2_{1/c}$ with Z = 4. Preliminary x-ray data were used to locate the approximate positions of the uranium and nonhydrogen atoms of the urea and water ligands, utilizing the heavy atom method. The atoms of the nitrate ions and hydrogen atoms were located and a least-squares refinement completed using neutron data to an $R_w = 4.7\%$. The uranyl ion is nearly linear with a U–O distance of 1.77 (2) Å and is surrounded by a planar pentagon consisting of five oxygen atoms, four from urea ligands at distances of 2.34 (1)–2.38 (1) Å and one from the water ligand at a distance of 2.46 (2) Å. The plane formed by these oxygen atoms is nearly perpendicular to the axis of the O–U–O ion. The structure is connected by an extensive system of hydrogen bonds which involve nitrate ions both through coordination and through bridging via hydrogen bonds. (auth)

47886 QUALITY CONTROL OF RADIOPHARMACEUTIC PRODUCTS FROM ISOTOPIC GENERATORS. **Cohen, Yves (CEN de Saclay, Gif-sur-Yvette, France). Ann. Pharm. Fr.; 29: No. 3, 191-200(1971). (In French).**

A description is given of the physical, chemical, and biological quality control to which radiopharmaceutical products from isotope generators are subjected. The quality control is characterized by its rapidity and simplicity in view of the brief physical lifetime of the radionuclides concerned, technetium-99m and indium-113m. (France)

47887 ECONOMICAL PROCEDURE FOR THE PREPARATION OF L-[^{35}S]METHIONINE OF HIGH SPECIFIC ACTIVITY. Graham, Rolland; Stanley, Wendell M. Jr. (Univ. of California, Irvine). Anal. Biochem.; 47: No. 2, 505-13(Jun 1972).

A simple low-cost method for the preparation and purification of L-[^{35}S] methionine from yeast is described. A minimum quantity of baker's yeast is allowed to double its mass in the presence of carrier-free $Na_2^{35}SO_4$ in a medium in which sulfur is growth limiting. After harvesting, the cells are heated and the denatured proteins are enzymically digested. The resultant free [^{35}S] methionine is then purified by paper chromatography. The recovered [^{35}S] methionine possesses greater than 90% isotopic purity and a specific activity between 10,000 and 40,000 Ci/mole. The radioactivity incorporated into methionine is approximately 40% of the input ^{35}S. When methionine of such high specific activity is stored in aqueous solution at concentrations of several mCi/ml, there is a rapid radioinduced oxidation of methionine to methionine sulfoxide. The addition of 2-mercaptoethanol or dithiothreitol reduces such oxidation to negligible levels. (auth)

47888 RAPID AND SIMPLE PROCEDURE FOR PREPARATION OF γ-^{32}P-LABELLED NUCLEOSIDE TRIPHOSPHATES. Keenan, Roy W.; Zishka, Mary K.; Nishimura, Jonathan S. (Univ. of Texas, San Antonio). Anal. Biochem.; 47: No. 2, 601-8(Jun 1972).

An enzymic procedure was devised for synthesis of nucleoside triphosphates labeled with ^{32}P in the γ-position. Conditions were determined that lead to high yields of radioactive products, which were shown to be labeled only in the γ-phosphate. This method is especially convenient and rapid because all of the enzymes and substrates required are commercially available. (auth)

47889 POLAROGRAPHY OF URANYL COMPLEX WITH p-AMINOTHIOPHENOXYACETIC ACID IN DIMETHYL SULFOXIDE SOLUTION. Lai, Tsai-teh; Yang, Jan-chin (Cheng Kung Univ., Tainan, Taiwan). Bull. Chem. Soc. Jap.; 45: No. 6, 1683-7(Jun 1972).

The polarography of the uranyl ion in dimethyl sulfoxide (DMSO) was investigated in the DMSO concentration range 40 to 99 vol%. The complex species identified is $UO_2(DMSO)_6^{2+}$; it is transformed into $UO_2(DMSO)_2^+$ and UO_2^+ after electrode reduction. In the presence of p-aminothiophenoxyacetic acid, the uranyl ion in the DMSO medium produces a two-step wave at lower pH and higher concentration of DMSO. The limiting current of the wave is controlled partially by the kinetics of the preceding chemical reaction and partially by the diffusion of the complex. The rate constant and diffusion coefficient of the reduction process were determined. At pH around 4, the formation of binuclear uranyl complexes was confirmed. (auth)

47890 FORCE FIELD STUDY OF HEXACHLORO TETRAVALENT NEPTUNIUM ION ($NpCl_6^{2-}$). **Sanyal, Nitish. K.; Dixit, L. (Univ. of Gorakhpur, India). Curr. Sci. (India); 41: No. 15, 562 (5 Aug 1972).**

Normal co-ordinate analysis of the ion $NpCl_6^{2-}$ using General Quadratic Potential Function and modified seven parameter Urey–Bradley force field is reported. Generalized mean square amplitudes of vibration and mean amplitudes of vibrations were evaluated. (M.C.G.)

47891 HYDROLYSIS OF PLUTONIUM (VI): ACIDITY MEASUREMENTS IN PERCHLORATE SOLUTIONS. Cassol, A.; Magon, L.; Portanova, R.; Tondello, E. (CNR, Padua). Radiochim. Acta; 17: No. 1, 28-32(May 72).

The hydrolysis equilibria of the plutonyl(VI) ion were studied at 25°C in solutions with 1M $(Na)ClO_4$ by emf measurements of $[H^+]$. The experimental data obtained at various Pu(VI) concentrations in the range 0.1 to 30 mM indicate that the main hydroxo complexes are polynuclear. Several combinations of hydrolysis products were tried in order to get the best fit with the data, using graphical procedures and a least squares program. It was concluded that, in the range of $\bar{n}$ values from 0 to 1, the species produced in important amounts and their equilibrium constants are: $[PuO_2(OH)]^+$, $\log{}^*\beta_{11} = -5.97 \pm 0.05$; $[(PuO_2)_2(OH)_2]^{2+}$, $\log{}^*\beta_{22} = -8.51 \pm 0.05$; $[(PuO_2)_3(OH)_5]^+$, $\log{}^*\beta_{53} = -22.16 \pm 0.03$. (auth)

47892 CRYSTALLINE STRUCTURE OF $Cs_2UO_2F_4.H_2O$. **Nguyen Quy Dao (Institut de Chimie, Chatenay-Malabry, France). Acta Crystallogr., Sect. B; 28: 2011-15(1972). (In French).**

$Cs_2UO_2F_4 \cdot H_2O$ crystallizes in the monoclinic system, space group $P2_1/c$: a = 8.06, b = 12.18, c = 9.29 Å, β = 109°12′. The structure is composed of Cs^+ ions, of water molecules, and of dimers with the formula $U_2O_4F_8^{4-}$. The dimer is formed by two $UO_2F_5^{3-}$ pentagonal bipyramids sharing a common edge of the pentagonal base. The U–F bridging bond is 2.4 Å, the U–F terminal bond 2.2 Å. The distance between the two uranium atoms inside the dimers is 4.04 Å while the shortest distance between two uranium atoms of two different dimers is 6.19 Å. The water molecule forms a bridge between two dimers. The hydrogen bonding is of medium strength. The cesium atoms are situated within the cavities and tunnel left by the chains of dimers and water molecules. (auth) (Denmark)

47893 POLAROGRAPHIC INVESTIGATION OF THE UO_2^{2+}–OXALIC ACID SYSTEM. **Manok, F.; Varhelyi, Cs.; Galateanu-Titieni, Minerva (Babes-Bolyai Univ., Cluj). Rev. Roum. Chim.; 17: No. 4, 675-82(Apr 1972). (In German).**

The system UO_2^{2+}–oxalic acid was studied polarographically in 5×10^{-2} N $HClO_4$. The increase in step height after addition of oxalic acid was explained as a bielectronic reduction of the uranium(VI) oxalate complex, in contrast to the monoelectronic reduction of the UO_2^{2+}. Measurement of changes in the polarographic step heights of U(VI) in the presence of a certain UO_2^{2+} ion concentration, permitted calculation of the formation constants of U(ox) and $U(ox)_2$: $\beta_1 = 1.0 \times 10^5$ and $\beta_2 = 5.6 \times 10^9$. These findings showed excellent agreement with those obtained potentiometrically. Logarithmic analysis of polarograms obtained with oxalic acid excess demonstrated that a uniform electrode process took place. The experiments proved that the polarographic reduction of the oxalate complexes of U(VI) is an irreversible process. (tr-auth)

47894 CRYSTAL STRUCTURE OF TRIURANIUM PENTASELENIDE. **Moseley, P. T. (Atomic Energy Research Establishment, Harwell, Eng.); Brown, D.; Whittaker, B. Acta Crystallogr., Sect. B; 28: 1816-21(1972).**

Triuranium pentaselenide, U_3Se_5, crystallizes with an orthorhombic unit cell; a_0 = 12.43 (2), b_0 = 8.48 (1) and c_0 = 7.77 (1) Å, Z = 4, space group probably Pnma. Two environmentally distinct types of uranium atom and two environmentally distinct types of selenium atom are found in the structure. Uranium–selenium interatomic distances range from 2.80 to 3.18 Å, varying with the coordination numbers of the atoms involved. The final R value for 615 reflexions, observed by the equi-inclination Weissenberg method, is 0.114. (auth) (Denmark)

47895 INTERACTION OF AMERICIUM(V) WITH ARSENAZO III. **Myasoedov, B. F.; Milyukova, M. S.; Ryzhova, L. V. (Inst. of Geochemistry and Analytical Chemistry, Moscow). Radiochem. Radioanal. Lett.; 11: No. 1, 39-44(31 Jul 1972).**

The interaction of americium(V) with Arsenazo III was investigated. Between pH 3 and 6 Am(V) forms with Arsenazo III a colored 1 : 1 complex. The solution of the complex shows two absorption maxima: at 560 and 650 nm. The molar extinction coefficient of the complex at pH 5.2 is 2.8×10^4. (auth)

47896 STUDY OF THE REDUCTION OF FERMIUM IN ACETIC ACID SOLUTION BY CONTROLLED POTENTIAL ELECTROLYSIS. David, F.; Hussonnois, M. (Paris Univ., Orsay, France). Radiochem. Radioanal. Lett.; 11: No. 1, 1-5(31 Jul 1972). (In French).

The half wave potential of the reaction: $Fm^{2+} + 2e^- + Hg \rightarrow Fm(Hg)$ was determined by controlled potential reduction in 0.05M acetic acid–0.05M lithium acetate medium. It was found that $E_{½}$ = −1.45 V/N.H.E. (auth)

47897 BEHAVIOR OF SOME 4f AND 5f ELEMENTS IN LIQUID AMMONIA. Jove, J.; Pages, M. (Laboratoire Curie, Paris). Radiochem. Radioanal. Lett.; 11: No. 1, 7-17(31 Jul 1972). (In French).

The cathodic reduction of Pr^{3+}, Eu^{2+}, Th^{4+}, U^{3+} and Am^{3+} was studied. Attempts to reduce Am^{3+} in liquid ammonia either with e^-_{am} furnished by dissolution of Na or by electrolysis failed. The Am(III)/(Am II) potential is found to be ≤−1.9 V in this medium. The polarogram of Am shows only one wave ($E_{½}$ = −2.04 V) that can be attributed to the reduction of Am(III) to Am^0. This confirms that the Am(II) oxidation state is less stable than has been expected. (auth)

47898 REACTION RATES OF URANIUM IONS AND ATOMS WITH O_2 AND N_2. Johnsen, R.; Biondi, Manfred A. (Univ. of Pittsburgh). J. Chem. Phys.; 57: No. 5, 1975-9(1 Sep 1972).

A drift mobility-tube-mass-spectrometer apparatus was used to study the ion-molecule reaction, $U^+ + O_2 \rightarrow UO^+ + O$, from thermal (300°K) energy to ~5 eV ion mean energy. At 300°K, the reaction rate is $(8.5, -1, +4) \times 10^{-10}$ cm³/sec and falls slowly with increasing ion energy to $\sim 7 \times 10^{-10}$ cm³/sec at 5 eV. The corresponding reaction of $U^+ + N_2$ is endothermic and not detected to occur up to ~5 eV ion energy. Chemi-ionization of uranium by the association reaction $U + O_2 \rightarrow UO_2^+ + e$ is detected. An estimate of the total reaction rate for $U + O_2$, including the oxidation branch to produce UO + O, yields a value $\sim 2 \times 10^{-12}$ cm³/sec at 300°K. Implications of these studies for ion cloud generation in the ionosphere are discussed. (auth)

47899 ABSORPTION SPECTRA OF $BkCl_3$ AND $CfCl_3$. Carnall, W. T.; Fried, S.; Wagner, F.; (and others) (Argonne National Lab., Ill.). Inorg. Nucl. Chem. Lett.; 8: No. 9, 773-4 (Sep 1972).

Low-temperature absorption spectra measurements on pure $BkCl_3$ and $CfCl_3$ are reported. In both cases transitions to components of the first excited multiplet levels were found in the near infrared region near the predicted energies. Using 1 to 2 mg samples it was possible to observe transitions up to ~40,000 cm⁻¹ at temperatures of 298, 77, and 4°K. The results established the energies of the lowest lying levels in Bk^{3+} and Cf^{3+} and make it possible to deduce some general trends in the transcurium range. Spin-orbit coupling constants obtained by simple linear extrapolation from the lighter actinides are consistent with the new data. Electrostatic interaction, however, was less than predicted and its treatment more complex than anticipated. Complete analysis of the data is in progress. (UK)

47900 STUDY BY THERMOCHROMATOGRAPHY OF THE FORMATION IN THE GASEOUS PHASE OF INTERHALOGEN COMPOUNDS OF ASTATINE. Merinis, J.; Legoux, Y.; Bouissieres, G. (Institut de Physique Nucleaire, Orsay, France). Radiochem. Radioanal. Lett.; 11: No. 1, 59-64(31 Jul 1972). (In French).

In the thermochromatographic study of astatine, the formation of AtCl, AtBr, AtI, deposited on quartz at temperature 100, 70, 35°C, respectively, was observed. (auth)

47901 REACTION OF REZARSON WITH CERTAIN ELEMENTS. Lukin, A. M.; Kaslina, N. A.; Fadeeva, V. I.; Petrova, G. S. Vestn. Mosk. Univ., Ser. II. Khim.; 13: No. 2, 247-9 (1972). (In Russian).

The reactions of 5-chloro-3-[(2,4-dihydroxyphenyl)azo]-2-hydroxybenzenearsonic acid(rezarson) U were studied by spectrophotometry. Optimal conditions for the reactions were determined, and molar extinction coefficients of the reactants were calculated. All the elements were found to interact with rezarson in the molar ratio 1 : 1. The most sensitive were reactions of rezarson with Cu, Ga, Sn, and Pd. (auth)

47902 SPLITTING OF THE $^3H_4$ TERM OF U^{4+} ION IN A LIGAND FIELD OF ARCHIMEDEAN ANTIPRISM SYMMETRY: MAGNETIC SUSCEPTIBILITY OF $U(SO_4)_2.4H_2O$ AND $U(CH_3COCHCOCH_3)_4$. Mulak, J.; Czopnik, A. (Inst. for Low Temperature and Structure Research, Wroclaw). Bull. Acad. Pol. Sci., Ser. Sci. Chim.; 20: No. 3, 209-16(1972).

The temperature dependence of the magnetic susceptibility for $U(SO_4)_2 \cdot 4H_2O$ and $U(CH_3COCHCOCH_3)_4$ within the range of 4.2 to 300°K was explained based on the splitting scheme of the $^3H_4$ term in a ligand field with D_{4d} symmetry and taking into consideration the distortions of low symmetry. U^{4+} ion in these compounds coordinates eight oxygen atoms constituting a slightly distorted Archimedean antiprism. The system of two singlets originating from doublet $|\pm 3>$ is the ground state of U^{4+} ion. These singlets are by about 100 and 50 cm⁻¹ apart for $U(SO_4)_2 \cdot 4H_2O$ and $U(Acac)_4$, respectively. (auth)

47903 LABELLING WITH TRITIUM OF CERTAIN PYRIMIDINE DERIVATIVES BY DEIODINATION. Kopecky, J. J.; Pavlu, B. (Inst. of Organic Chemistry and Biochemistry, Prague). Collect. Czech. Chem. Commun.; 37: No. 6, 2039-42(Jun 1972).

A simple method for labeling of pyrimidine derivatives by tritium is described. The method essentially consists of heating 5-iodopyrimidine in dimethyl sulfoxide containing 5% ^3H_2O. The specific activity obtained by this method is comparable with the specific activity of the product prepared by catalytic reaction. (auth)

47904 MECHANISM OF QUENCHING OF THE URANYL FLUORESCENCE BY ORGANIC COMPOUNDS. Matsushima, Ryoka (Shizuola Univ., Hamamatsu, Japan). J. Amer. Chem. Soc.; 94: No. 17, 6010-15(23 Aug 1972).

Quenching constants of the uranyl fluorescence by aromatic molecules and aliphatic alcohols were obtained from the Stern–Volmer plots in solutions at room temperature. Quenching by the aromatic quenchers, which have no excited states lying below that of the uranyl ions, occurred very efficiently without chemical changes. There was no kinetic isotope effect, i.e., $K_q(C_6H_6)/K_q(C_6D_6) = 1.0$, which would indicate no contribution of vibrational factors of aromatic quenchers in the rate-determining step. Relative quenching rates of aromatic quenchers showed close correlations with Yukawa–Tsuno's σ values, with ionization potentials, and with rates of thermal aromatic nitrations, suggesting an important role of electron donor-acceptor interactions. Further, close correlation of relative quenching rates with relative π complex stabilities of alkylbenzenes suggested the formation of a π complex between the quenchers and the excited uranyl ions, though there would be no affinities in the ground state. On the other hand, quenching by aliphatic alcohols appeared to involve a chemical process (α-hydrogen abstraction), on the basis of kinetic isotope effects, positive activation energies for the photoredox rates, and correlation of the photoredox quantum yield with the sum of Taft's σ values, $\Sigma\sigma^*$. From these facts it was suggested that quenching of the uranyl fluorescence by aromatic quenchers and aliphatic alcohols took place via nonelectronic–electronic energy transfer; quenching by aromatic quenchers appeared to proceed through physical radiationless decay of an exciplex intermediate, while quenching by aliphatic alcohols seemed to proceed through a chemical decay of a similar intermediate. (auth)

47905 COMPLEXATION OF SOME ACTINIDE IONS WITH SQUARIC ACID. Cilindro, L. G.; Stadlbauer, E.; Keller, C. (Kernforschungszentrum, Karlsruhe, Ger.). J. Inorg. Nucl. Chem.: 34: No. 8. 2577-81(Aug 1972).

The complexation of Ac(III), Am(III), Cm(III), Cf(III), and Th(IV) with squaric acid in aqueous solution at 25°C and ionic strength 1.0 was investigated by cation exchange distribution measurements. Relatively weak 1 : 1 and 1 : 2 complexes were formed in all cases, with the stability constants increasing in the above-written sequence from $\log \beta_1 = 1.85$ and $\log \beta_2 = 2.74$ for the actinium system to $\log \beta_1 = 4.08$ and $\log \beta_2 = 7.32$ for the thorium system. Np(V), studied by spectrophotometric titration, did not undergo any detectable complexation at all. (auth)

47906 KINETIC STUDY OF THE REACTION OF THORIUM OXIDE WITH HYDROFLUORIC ACID. Takeuchi, T.; Kawamura, K. (National Research Inst. for Metals, Tokyo). J. Inorg. Nucl. Chem.; 34: No. 8, 2497-2503(Aug 1972).

The rate of reaction of thoria with hydrofluoric acid was measured by means of a fluoride ion selective electrode, and the following results were obtained: (1) the reactive species is a fluoride ion; (2) reaction of fluoride ions consumes equivalent amount of hydrogen ions; and (3) the activation energy is small. From these facts, the reaction is considered to be an anion exchange reaction of surface hydroxyl ions with fluoride ions, and the hydrogen ions act to neutralize the liberated hydroxyl ions. (auth)

47907 PREPARATION OF SOME ADDUCTS OF THE GENERAL FORMULA $UO_2((C_2H_5)NCS_2)_2L$. Siddall, T. H. (Louisiana State Univ., New Orleans); Voisin, C. F. J. Inorg. Nucl. Chem.; 34: No. 6, 2078-81(Jun 1972).

Earlier work on uranyl dithiocarbamate adducts was extended to the preparation of adducts with a wide variety of ligands, covering amides, organophosphorus compounds, sulphoxides, pyridines, and pyrazoles. Details are given of the methods of preparation. Successful preparations were achieved with three classes of ligands with O as the complexing site and two with N as the site, forming adducts all with the same stoichiometry. Repeated efforts failed to yield an adduct with tributyl phosphate. (UK)

Radioactive Waste Treatment

Refer also to abstract 47721.

47908 (BNWL-CC-2143) DBBP EXTRACTION OF NEPTUNIUM FROM PUREX ACID SLUDGE SOLUTIONS. Schulz, Wallace W. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). 15 Jun 1969. 27p. Dep. NTIS.

A batch solvent extraction process, which employs dibutyl butylphosphonate (DBBP) as the extractant, was devised for recovery of neptunium from Purex acid sludge (PAS) solution. Laboratory tests of the process with both synthetic and actual PAS solutions are described. Ferrous sulfamate is added to the PAS solution to adjust neptunium to the tetravalent state. One portion of 25 vol % DBBP extractant is contacted successively with three approximately half-volume portions of the adjusted PAS feed to extract about 90% of the neptunium. About 70% of the Pu and 50% of the ^{154}Eu also extract. A detailed chemical flowsheet is presented. A significant feature of the process is that about 70% of the ^{241}Am in the PAS feed also extracts into the DBBP solvent. (M.C.G.)

47909 (JAERI-Memo-4053) TREATMENT OF LOW LEVEL SOLID WASTES IN TOKAI RESEARCH ESTABLISHMENT OF JAERI. Hirayama, Katsuyoshi (Japan Atomic Energy Research Inst., Tokyo). Jun 1970. (In Japanese). NTIS (U. S. Sales Only).

Methods of processing and troubles at installations regarding low-level solid wastes in the Tokai Research Establishment are shown. The design and construction of installations used to treat radioactive solid wastes in the nuclear power facilities is considered. (auth)

47910 (JAERI-Memo-4080) PROCESSING OF RADIOACTIVE LIQUID WASTE WITH ION EXCHANGE MEMBRANE METHOD: AN EXPERIMENTAL INVESTIGATION. Aikawa, Hideaki; Takagi, Shinji (Japan Atomic Energy Research Inst., Tokyo). Jul 1970. (In Japanese). NTIS (U. S. Sales Only).

Processing of radioactive liquid waste using ion exchange membrane method is more efficient than using an exchange resin in treatment of various kinds of radioactive liquid wastes. In experimental research this method was especially suitable for treatment of radioactive liquid wastes that contain $^{137}Cs^+$. The maximum decontamination factor of 50 for the isotope was obtained with 3 hours of operation of ion exchange membrane equipment when 350 ppM of sodium chloride was added to the standard sample solution. This method was applied to the processing of liquid waste originating in ruptured fuel cans with one of the liquid wastes containing $^{137}Cs^+$. (auth)

47911 REMOVAL OF ^{239}Pu FROM AQUEOUS SOLUTION BY COPRECIPITATION WITH IRON(III) HYDROXIDE. Matsuzuru, Hideo (Japan Atomic Energy Research Inst., Tokai); Wadachi, Yoshiki; Hashino, Toshio. Radioisotopes (Tokyo); 21: No. 6, 333-7(Jun 1972). (In Japanese).

The removal of ^{239}Pu with or without accompanying fission products from aqueous solution by coprecipitation with iron(III) hydroxide was studied as a function of solution pH and the concentration of ^{239}Pu, the coprecipitant, and sodium nitrate added to the mixed system. It was shown that ^{239}Pu is removed more efficiently by increasing the pH throughout the range of pH 5 to 8; beyond this value the decontamination factor (DF) is saturated to give a constant value of $(3 \text{ to } 4) \times 10^2$ up to pH 12. An addition of the electrolyte, sodium nitrate, did not affect the removal of ^{239}Pu throughout the concentration from 0.1 to 1 M, whereas at the concentration of 0.01 M, iron(III) hydroxide was dispersed finely to result in the formation of a colloidal solution leading to a decreased DF value. The coprecipitant concentration required for the sufficient removal was found to be ca. 500 ppM. The DF value was not dependent on the ^{239}Pu concentration in the range of 1×10^{-4} to 2×10^{-1} μCi/ml. DF of ^{239}Pu remained unchanged by the addition of fission products to the contaminant solution. (auth)

47912 ESTER PROGRAM: HIGH-LEVEL RADIOACTIVE WASTE SOLIDIFICATION. BOROSILICATE GLASS EXPERIMENTAL EVALUATION AND BENCH-SCALE VITRIFICATION WITH SIMULATED FISSION PRODUCT SOLUTIONS. Donato, A.; Bocola, W. (CNEN, Rome). Energ. Nucl. (Milan); 19: No. 7, 459-69(Jul 1972).

A phosphate glass process for solidification of fission product solutions, developed in the frame of ESTER Program, was previously reported. Studies carried out on the use of borosilicate glasses as an alternative to phosphate glasses, to solidify a solution of this type, are reported. Twenty glass samples, containing 3.6 to 18.0 wt% and 1.7 to 12.0% in moles of fission product oxides, were prepared in batch. Through experimental evaluation of the most significant glass properties (working temperature, leachability and volume reduction factor), a few compositions were selected to test the borosilicate glass solidification process. Eleven bench-scale vitrification tests were carried out. The solids obtained were of glassy type and their leachability determined at 25°C in distilled water, was on the average 10^{-6} g $\cdot$ cm^{-2} $\cdot$ d^{-1}. By means of a suitable $SiO_2-Fe_2O_3$ filter, the ruthenium loss from the pot was lowered to about 0.6%. (auth)

47913 METHOD OF REMOVING NITRIC ACID, NITRATE IONS, AND NITRITE IONS OUT OF AQUEOUS WASTE SOLUTIONS. Drobnik, Stephan (to Gesellschaft fuer Kernforschung mbH). U. S. Patent 3,673,086. 27 Jun 1972. Priority date 11 Jul 1969, Germany.

Nitric acid, nitrate ions, and nitrite ions are removed from aqueous radioactive waste solutions by treating such solutions with a reducing agent. The aqueous waste is fed into a heated aqueous solution of the reducing agent (essentially formic acid). The off-gas is predominantly CO_2 and N_2O. (M.C.G.)

47914 TREATMENT OF PLUTONIUM LIQUID WASTES BY FLOCCULATION. Matsuzuru, Hideo (Japan Atomic Energy Research Inst., Tokai); Koyama, Kazuo; Wadachi, Yoshiki. Nippon Genshiryoku Gakkaishi; 14: No. 6, 290-4(Jun 1972). (In Japanese).

The treatment conditions for alkaline flocculation of acidic plutonium liquid wastes were studied, using ferric hydroxide and calcium phosphate as flocculants. It was found that the decontamination factor (DF) for ferric hydroxide or calcium phosphate flocculation is about 10^3 when the plutonium concentration is 6.5×10^{-3} μCi/ml under the treatment conditions of 500 ppM flocculant concentration, pH 10 to 13, and 0.1M salt concentration. In order to obtain higher DF, repetition of treatment is proposed. It was observed that by one repetition of flocculation (ferric hydroxide—ferric hydroxide and ferric hydroxide—calcium phosphate), the DF is enhanced up to 10^5 or more when the plutonium concentration is 1.6 μCi/ml under the treatment conditions described above. (auth)

47915 COLLECTING SYSTEM FOR GASEOUS MATTERS. COLLECTION OF RADIOACTIVE IODINE BY CHARCOAL FILTERS. Murata, T. (Hitachi Ltd., Tokyo). Kuki Seijo; 8: No. 7, 41-8(Mar 1971). (In Japanese).

Various studies on collection characteristics of charcoal filters for iodine are summarized. The equilibrium adsorption capacity of charcoal for elementary iodine and methyl iodide is given as an experimental relationship. When mechanical characteristics of the charcoal filters are perfect, performance of the charcoal filters depends upon the charcoal itself. Elementary iodine removal efficiency of the charcoal was measured, and the result reassured extremely high efficiency under high relative humidity. Efficiency increased with temperature and very slightly increased with increasing relative humidity. This removal efficiency rapidly decreased with introduction of water drops into the air. However, methyl iodide removal efficiency is largely affected by humidity, and decreased rapidly between 40 and 80% relative humidity, and nearly to zero at about 100% relative humidity, while steam adsorption increased significantly between 40 and 80% relative humidity. Therefore, demisters and gas heaters are provided in front of the charcoal filters for light water reactors, but the relative humidity of passing gas is considered conservatively in filter performance evaluation. Charcoal impregnated with either organic amines, stable iodine, or iodide shows very high efficiency under high humidity. Most optimal impregnation materials seem to be 5 to 10 weight % of triethylenediamine (TEDA) and 0.1 to 1 weight % of potassium iodide. The efficiency can be improved up to 90% or more. Variation in the efficiency of removal of methyl iodide depends on charcoal type, particle size, method of the impregnation, etc. There is a limit in amount of adsorbed methyl iodide for the impregnated charcoal, but apparently the impregnation does not hinder the adsorption of elementary iodine up to 1 mg. (auth)

Radioisotope Production

47916 (JAERI-Memo-3890) IMPURITIES IN PROCESSED RADIOISOTOPES PRODUCED BY THE (n,γ) REACTION: PURITY OF ^{152}Eu. Kubota, M.; Amano, H. (Japan Atomic Energy Research Inst., Tokyo). Jan 1970. (In Japanese). NTIS (U. S. Sales Only).

Impurities in europium oxide were determined in order to estimate the radiochemical purity of ^{152}Eu (half-life 13y) which is to be produced by a (n,γ) reaction on this material. As a result of quantitative analysis of impurities by means of the usual activation method, 87% Gd, 0.23% Sm, 1.1 ppM Sc, 2.2 ppM Lu, and 14 ppM Yb were found in the target material. The values for Gd and Sm were greatly different from results obtained by activation analysis carried out on impurities separated chemically before neutron irradiation. This discrepancy was due to the formation of ^{153}Gd and ^{153}Sm by the secondary reaction on ^{152}Eu with thermal neutrons. The radiochemical purity of ^{152}Eu proved to be higher than 96% at times immediately after irradiation for 130 hours in a neutron flux of 1×10^{13} n/cm · sec, the presence of ^{152m}Eu (half-life 9.3 hr) being ignored. At this time, main components of the impurities are 3.2% ^{153}Sm (half-life 47 hr) and 0.1% ^{153}Gd (half-life 242d) formed by the secondary reaction. (auth)

47917 (JAERI-Memo-3897) STUDY ON THE PRODUCTION OF ^{14}C. I. DETERMINATION OF IMPURITIES IN ALUMINUM NITRIDE–TARGET AND ITS STABILITY AGAINST REACTOR IRRADIATION. Hata, K.; Shikata, E.; Amano, H. (Japan Atomic Energy Research Inst., Tokyo). Jan 1970. (In Japanese). NTIS (U. S. Sales Only).

In order to discuss the fitness of aluminum nitride, AIN, as a target material for ^{14}C production, the stability of AIN against reactor irradiation and its purity were determined. The stability of the nitride was estimated by analyzing qualitatively and quantitatively the constituents of gases evolved by reactor-irradiation and by determining the nitrogen content of the nitride before and after irradiation. As for the purity of AIN, chemical impurities capable of producing long-lived induced activities by reactor-irradiation were determined by the activation method and conditions suitable for microanalysis of carbon in the nitride was studied. Although aluminum nitride showed a little decomposition on the irradiation in JRR-2 and -3, it showed high enough stability against reactor irradiation for practical purposes. As chemical impurities, Cr, Hf, Co, Fe, and Sc were found commonly among six aluminum nitrides from different manufacturers. (auth)

47918 (JAERI-Memo-3939) PRODUCTION OF $^{197\ 203}$Hg. I. DEVELOPMENT OF IRRADIATION TECHNIQUES. (Japan Atomic Energy Research Inst., Tokyo). Jan 1970. (In Japanese). NTIS (U. S. Sales Only).

For the production of ^{197}Hg and ^{203}Hg by (n,γ) reactions of particular safety conditions are desired for irradiation of target materials, because mercury is very volatile and sublimates easily. The chemical form of the target material, its stability against heat and radiation and examination of the safety of the target assembly for routine irradiation of mercury compounds by the reactor were determined. Mercuric oxide (HgO) was employed as a target material and its stability against heat tested. No decomposition was recognized below 380°C. For ^{197}Hg production, 0.15 gr HgO was sealed in a quartz ampoule, cold-welded in a DL type inner capsule, and cold-welded in a DL type outer capsule. For ^{203}Hg production 1.0 gr HgO was sealed in a quartz ampoule, sealed with welding in a stainless steel inner capsule and cold-welded in an outer capsule. Irradiation has started with assurance of safety for routine irradiation. (M.C.G.)

47919 (JAERI-Memo-3955) IMPURITIES IN PROCESSED RADIOISOTOPES PRODUCED BY THE (n,γ) REACTION: PURITIES OF ^{140}La AND ^{170}Tm. Kubota, M.; Amano, H. (Japan Atomic Energy Research Inst., Tokyo). Feb 1970. (In Japanese). NTIS (U. S. Sales Only).

Radiochemical impurities in ^{140}La and ^{170}Tm produced by the (n,γ) reactions were determined on oxides of lanthanum and thulium. Impurities in the target materials were determined quantitatively by radioactivation analysis combined with ion-exchange separation. Impurities of 8.0 ppM Ce, <80 ppM Pr, 2.1 ppM Tm, and 1.5 ppM Lu were found in lanthanum oxide and 5.46 ppM Lu and 93.8 ppM Yb in thulium oxide. On the basis of these results, the radiochemical purity of ^{140}La at the time immediately after irradiation for 20 minutes in a neutron flux of 1×10^{13} n/cm and that of ^{170}Tm at a time of 24 hours after irradiation for 130 hours were calculated to be higher than 99.9%, and the specific activities of these isotopes were estimated to be 55 mCi/g · La and 3.6 Ci/g · Tm, respectively. (auth)

47920 IONIC AND COLLOIDAL FLOTATION OF ^{144}Ce(III) AND ^{147}Pm(III). Kepak, F.; Kriva, J. (Nuclear Research Inst., Rez, Czech.). Separ. Sci.; 7: No. 4, 433-40(1972).

Ionic and colloidal flotation of ^{144}Ce(III) and ^{147}Pm(III) were studied on a laboratory scale from aqueous solutions with anion-active, cation-active, or non-ionic surface-active substances and the dependence on pH, on the concentration of the separated component, and on the surface-inactive electrolyte shown. In addition to separation in one stage, multistage separation was also used in order to achieve higher efficiency. (auth)

47921 REACTOR PRODUCTION OF ^{56}Co AND ^{58}Co. Cann, C.; Chyen, P.-C.; Prussin, S. G. (Univ. of California, Berkeley). Radiochim. Acta; 17: No. 1, 38-40(May 1972).

The preparation of ^{56}Co and ^{58}Co by (T,n) reactions on iron with tritons from the reaction ^{6}Li(n,α)T was studied. Production rates for these isotopes in a reactor neutron flux are given and it has been shown that the reactions result primarily from the absorption of thermal neutrons in ^{6}Li. (auth)

47922 SEPARATION OF CARRIER-FREE ^{125}Sb FROM METALLIC TIN TARGET. Kambara, Tomihisa; Ando, Tsuneyuki (Shizuoka Univ., Japan). Rep. Fac. Sci., Shizuoka Univ.; 6: 83-6(Dec 1971).

In order to obtain carrier-free ^{125}Sb from a neutron-irradiated tin target, a new method for separation of macro amounts of tin and ^{125}Sb was investigated. The method involves the extraction of tin as thiocyanate complex into isopropyl ether from dilute hydrochloric acid solutions containing ^{125}Sb. Excellent results were obtained with the extraction method. By use of this separation procedure the ^{125}Sb separation from the tin target was carried out. The procedure consists of dissolution of the tin target and evaporation, extraction of tin to eliminate the target element from ^{125}Sb, and purification of ^{125}Sb. The average total yield of ^{125}Sb was 80%, containing only trace impurities. (auth)

47923 ELUTION POSITIONS OF EUROPIUM, BERKELIUM, TERBIUM, AND EINSTEINIUM FROM A CATION EXCHANGE RESIN COLUMN WITH α-HYDROXYISOBUTYRIC ACID. Harbour, R. M. (E. I. du Pont de Nemours and Co., Aiken, S. C.). J. Inorg. Nucl. Chem.; 34: No. 8, 2680-1(Aug 1972).

The gamma-emitting nuclides ^{154}Eu and ^{160}Tb were used as on-line monitors for collection of ^{249}Bk and ^{254g}Es, respectively, in the large-scale cation exchange separation of transplutonium actinides. Published data indicated that europium elutes slightly ahead of berkelium and terbium elutes just after einsteinium. The differences between the absolute values were small, however, and it was decided to redetermine the elution order in separations in which both actinides and lanthanides were present. The separations were made in a cation exchange resin column using α-hydroxyisobutyric acid (AHIB) as the elutriant. The results showed that berkelium actually elutes ahead of europium and that terbium and einsteinium elute together. ^{160}Tb is therefore an ideal monitor for ^{254g}Es. If ^{154}Eu is used as an on-line monitor for ^{249}Bk, however, some fraction of the ^{249}Bk will have eluted before the ^{154}Eu appears. (UK)

47924 SEPARATION OF PLUTONIUM AND CURIUM FROM IRRADIATED AMERICIUM BY SOLVENT EXTRACTION USING HDEHP. Watanabe, Kenju; Sagawa, Chiaki (Japan Atomic Energy Research Inst., Tokai). Nippon Genshiryoku Gakkaishi; 14: No. 7, 326-30(Jul 1972). (In Japanese).

Separation of ^{238}Pu and ^{242}Cm from irradiated ^{241}Am was performed by means of solvent extraction using bis(2-ethylhexyl) phosphate (DEHPA). From a 0.1M nitric acid mixed solution, ^{238}Pu and ^{242}Cm were extracted by 50% DEHPA xylene or dodecane solution, leaving ^{241}Am(V) in the aqueous solution. The extraction was made immediately after reducing Am(VI) to Am(V) with hydrogen peroxide. ^{242}Cm and ^{238}Pu were stripped from the organic solution into 1M nitric acid and 9M hydrochloric acid–2.5% ferrous sulfamate solutions, respectively. The decontamination factor of ^{241}Am for ^{242}Cm was 30 ± 10 for one cycle of the separation procedure. The yield of ^{238}Pu, ^{241}Am, or ^{242}Cm was 80, 95 ~ 97 or 70 ~ 98%, respectively. (auth)

Reactor Fuel Reprocessing

Refer also to abstracts 47683, 47722, 47725, 47736, 47739, 49792, and 49827.

47925 (ARH-1981) BATCH DISSOLUTION OF INCINERATOR ASH. Panesko, J. Vincent (Atlantic Richfield Hanford Co., Richland, Wash.). Feb 1971. Contract AT(45-1)-2130. 13p. Dep. NTIS.

Optimum conditions for the dissolution of incinerator ash were found and demonstrated. Plutonium recovery ranged from 95 to 100% using HNO_3 – 0.3M CaF_2 at 100°C. Plutonium dissolution could be obtained as readily with 5M HNO_3 as with 10M HNO_3 provided the fluoride was 0.6M. Plutonium dissolution was more than 80%

complete within 15 minutes; longer contact times yielded trace or no additional dissolution. The number of multiple contacts required for greater than 99% plutonium recovery varied from 2 to 4, depending on the plutonium content of the ash. Solids dissolution ranged from 40 to 70 vol % using the same conditions which yielded greater than 95% plutonium recovery. When ash was reburned prior to chemical treatment, solids dissolution ranged from 60 to 95%. Reburning alone yielded a 20 vol % and a 15 wt % reduction in the three out of four cans of ash studied. (auth)

47926 (ARH-SA-116) USE OF IN-LINE MONITORS FOR PROCESS CONTROL OF THE HANFORD PUREX PLANT. Jones, H. M.; Lyon, R. Y. (Atlantic Richfield Hanford Co., Richland, Wash.). 17 May 1972. Contract AT(45-1)-2130. 32p. (CONF-720903-7). Dep. NTIS.

From twentieth remote systems technology conference; Idaho Falls, ID. (17 Sep 1972).

Gamma, alpha, neutron, photometer, conductivity, and fluoride in-line monitors were developed to provide process control for the Hanford Purex Fuels Reprocessing Plant. The installation and operating experiences of each monitor are described. Most of these concepts should be adaptable to commercial reprocessing plants. (auth)

47927 (ARH-SA-129) MACRORETICULAR ANION EXCHANGE RESIN CLEANUP OF TBP SOLVENTS. Schulz, Wallace W. (Atlantic Richfield Hanford Co., Richland, Wash.). 15 May 1972. Contract AT(45-1)-2130. 37p. (CONF-720607-21). Dep. NTIS.

From eighteenth annual American Nuclear Society conference; Las Vegas, NV. (18 Jun 1972).

Strong-base macroreticular anion exchange resins (e.g., Amberlyst A-26) remove fission products, dibutyl phosphoric acid, and diluent degradation products from used TBP extractants. Application of these resins in routine cleanup of such solvents is potentially attractive to eliminate or, at least, minimize the large volumes of radioactive waste generated by presently used solvent wash procedures. Column tests with both unwashed Hanford Purex plant 30% TBP—NPH and Plutonium Reclamation Facility 20% TBP—CCl_4 solvents demonstrate the high capacity of A-26 resin for sorbing solvent impurities. Chemical and physical properties of resin-treated solvent, according to various solvent quality indices and mixer-settler tests, are comparable with those of carbonate-washed extractant. Resin beds used to treat Purex process solvent can be regenerated by successive treatment with 3M HNO_3—0.025M HF and 1M NaOH solutions. Alternatively, spent resin can be disposed of by incineration at 750°C. Conceptual flowsheets for resin cleanup of typical TBP extractants are described. (auth)

47928 (BARC-589) PILOT PLANT STUDIES WITH A PULSED SOLVENT EXTRACTION COLUMN. Srinivasan, N.; Kumar, S. V.; Rajagopalan, S.; Pillai, P. R. R. (Bhabha Atomic Research Centre, Bombay (India)). 1972. 20p. Dep. NTIS (U. S. Sales Only).

Experiments on a pulsed solvent extraction column (50 mm dia, 2400 mm long, stainless steel, sieve plates with 3 mm holes, 23% free area with 50 mm spacing) using direct air purging for interface measurement, pulsing by pneumatic system with an electronic timer and aqueous discharge by air lift with the control valve in the air line of the air lift system, are described. Characteristics of air pulsing and the pulse amplitude in the column were also studied. The flooding velocity was determined by measurement of column hold-up. (M.C.G.)

47929 (CONF-720821-1) EQUILIBRIUM DISTRIBUTION OF LITHIUM AND BISMUTH BETWEEN LIQUID Li–Bi ALLOYS AND MOLTEN LiCl AT 650 TO 800^{0}C. Ferris, L. M.; Bredig, M. A.; Smith, F. J. (Oak Ridge National Lab., Tenn.). 1971. 25p. Dep. NTIS.

From 164th National American Chemical Society meeting; New York, NY. (27 Aug 1972).

The distribution of lithium and bismuth between liquid Li—Bi alloys and molten LiCl was measured at several temperatures between 650 and 800°C. The extent of their distribution to the LiCl increased at each temperature as the lithium concentration in the alloy increased; for example, at 650°C, the bismuth concentration in the LiCl increased from about 5 to 4800 ppM as the lithium concentration in the alloy increased from 10 to 50 at. %. The "free" lithium-to-bismuth ratio in the LiCl was 3, suggesting that saltlike Li_3Be was distributing between the two phases. In a model describing this process, the species Li^+, Bi^{3-}, Bi^0 were assumed to be present in the alloy phase. The experimental data fit the model in that, at each temperature, a plot of $\log N_{Li_3Bi(d)}$ vs. $\log ({N^4}_{Li(m)} [3 - N_{Li(m)}]^{-3} [3 - 3N_{Li(m)}]^{-1})$ was linear with the expected unit slope. In these expressions, N, (d), and (m) denote mole fraction, dissolved in the salt phase, and dissolved in the alloy phase, respectively. Data obtained over the temperature range 650 to 800°C can be expressed as: $\log N_{Li_3Bi(d)} = \log ({N^4}_{Li(m)} [3 - N_{Li(m)}]^{-3} [3 - 3N_{Li(m)}]^{-1}) + 0.7256 - 1086/T(°K)$, with an estimated uncertainty in $\log N_{Li_3Bi(d)}$ of ±0.05. The data could also be accurately represented by a model in which random mixing of Li^+, Bi^{3-}, and Bi^0 in the alloy phase was assumed. (auth)

47930 (CONF-720821-3) EQUILIBRIUM PRECIPITATION OF PROTACTINIUM OXIDE FROM MOLTEN LiF–BeF_2–ThF_4–UF_4–PaF_5 MIXTURES. Tallent, O. K.; Ferris, L. M. (Oak Ridge National Lab., Tenn.). [nd]. 17p. Dep. NTIS.

From one hundred and sixty-fourth National American Chemical Society meeting; New York, NY. (27 Aug 1972).

Studies are being made to develop a precipitation process for separating protactinium from an MSBR-type fuel salt without otherwise appreciably changing the salt. The feasibility of precipitation of protactinium as Pa_2O_5 by passing mixed H_2O-HF gas through the salt was investigated. One hundred to two hundred grams of LiF—BeF_2—ThF_4—UF_4 (71—16—12—~0.8 mole %) containing enough ^{231}Pa to give ~100 ppM and enough ^{233}Pa tracer to give about 30,000 γ cts/g were exposed to a mixed Hf—H_2O—Ar gas and the precipitated salt analyzed for U and Pa. Data indicate that it will be impossible to precipitate a large fraction of the protactinium without precipitating some UO_2. (M.C.G.)

47931 (DP-Report-470) PRELIMINARY SUMMARY OF THE ESTIMATED COSTS OF REPROCESSING AND REFABRICATION OF HTR FUELS. Project DRAGON. Short, G. D. C.; Wharton, J. (Atomic Energy Establishment, Winfrith (England)). Apr 1967. 30p. Dep. NTIS (U. S. Sales Only).

Technical assumptions are given for a conceptual fuel reprocessing and refabrication site for fuel from a 10,000 MW(th) HTGCR program based on homogeneous uranium—thorium fuel. Interim capital and operating costs are presented for an integrated site and for reprocessing and refabricating coated particle uranium—thorium carbide fuels by the low decontamination remote refabrication route. (auth)

47932 (ORNL-TM-3312) LMFBR FUEL CYCLE STUDIES PROGRESS REPORT FOR JANUARY 1971, NO. 23. (Oak Ridge National Lab., Tenn.). Feb 1971. Contract W-7405-eng-26. 112p. Dep. NTIS.

This report continues a series outlining progress in the development of methods for the reprocessing and fabrication of LMFBR fuels. Development work is reported on problems of irradiated fuel transport to the processing facility, the dissolution of the fuel and the chemical recovery of the PuO_2—UO_2 values, the containment of volatile fission products, product purification, preparation of fuel material by the sol-gel process, conversion of fuel processing plant product nitrate solutions to solids suitable for shipping and for fuel fabrication, fuel fabrication of sol-gel materials, and fuel evaluation studies, both in-pile and out-of-pile. Pertinent experimental results are presented for the information of those immediately concerned with the field. Detailed description of experimental work and data are included in topical reports and in the Chemical Technology Division and Metals and Ceramics Division Annual Reports. (auth)

47933 (ORNL-TM-3345) LMFBR FUEL CYCLE STUDIES PROGRESS REPORT FOR FEBRUARY 1971, NO. 24. (Oak Ridge National Lab., Tenn.). Mar 1971. Contract W-7405-eng-26. 72p. Dep. NTIS.

FISSION PRODUCTS—volatilization from oxide fuels
 —diffusion in oxide fuels
IODINE—separation from off-gases from LMFBR fuel reprocessing
LIQUID METAL FAST BREEDER REACTOR—fuel cycle development studies (February 1971) for
METHANE, IODO—separation from air by trapping in nitric acid reflux system
NEUTRONS—effects on stainless steel
PLUTONIUM—purification in Purex Process
PLUTONIUM OXIDES PuO_2—PuO_2—UO_2, dissolution in nitric acid
 —preparation of sinterable powders of
 —PuO_2—UO_2, preparation from LMFBR reprocessing solution by sol-gel process
 —PuO_2—UO_2, radiation effects on sol-gel-derived, neutron
REACTOR FUEL ELEMENTS—shipment of spent LMFBR, cask studies for
 —reprocessing of LMFBR, sodium removal in head-end
 —reprocessing of oxide, voloxidation for fission product removal in head-end
 —fabrication requirements of oxide
 —radiation effects on, tests for evaluation of
 —performance evaluation of oxide

REACTOR FUELS—reprocessing of LMFBR, research progress (February 1971) on aqueous
SODIUM—removal from spent LMFBR fuel elements
STAINLESS STEEL—radiation effects on, neutron
URANIUM OXIDES UO_2—PuO_2-UO_2, oxidation of pellets of
—preparation of sinterable powders of
—preparation of sols of, CUSP process for
—PuO_2-UO_2, fabrication of (M.C.G.)

47934 (ORNL-TM-3375) LMFBR FUEL CYCLE STUDIES PROGRESS REPORT FOR MARCH 1971, NO. 25. (Oak Ridge National Lab., Tenn.). Apr 1971. Contract W-7405-eng-26. 86p. Dep. NTIS.

ACTINIDES—distributions in irradiated fuels
FISSION PRODUCTS—diffusion in oxide fuels
IODINE—partition between gas and solution
—separation from fuel reprocessing off-gases
LIQUID METAL FAST BREEDER REACTOR—fuel cycle development studies (March 1971) on
METHANE, IODO—separation from air by scrubbing with concentrated nitric acid
PLUTONIUM OXIDES PuO_2—preparation from solutions from fuel reprocessing
—PuO_2-UO_2, radiation effects on sol-gel-derived
REACTOR FUEL ELEMENTS—shipment of spent LMFBR, cask heat dissipation tests for
—reprocessing of spent LMFBR, sodium removal in head-end
—performance of LMFBR, predicted and measured
REACTOR FUELS—reprocessing of LMFBR, research progress (March 1971) on aqueous
—radiation properties of spent LMFBR
—shielding of spent LMFBR
SODIUM—removal from spent LMFBR fuels
URANIUM OXIDES UO_2—PuO_2-UO_2, oxidation of
—preparation from solutions from fuel reprocessing
—preparation of sols of, CUSP process for
—preparation of microspheres of
—PuO_2-UO_2, fabrication of sol-gel-derived (M.C.G.)

47935 (ORNL-TM-3487) LMFBR FUEL CYCLE STUDIES PROGRESS REPORT FOR JUNE 1971, NO. 28. (Oak Ridge National Lab., Tenn.). Jul 1971. Contract W-7405-eng-26. 59p. Dep. NTIS.

FISSION PRODUCTS—volatilization from spent oxide fuels
IODINE—separation from fuel reprocessing off-gases
—separation from air by trapping using nitric acid or sorption on solids
LIQUID METAL FAST BREEDER REACTOR—fuel cycle development studies (June 1971) for
METHANE, IODO—separation from air by trapping using nitric acid or sorption on solids
PLUTONIUM—purification in Purex Process
PLUTONIUM OXIDES PuO_2—preparation from solutions from fuel reprocessing cycle
—PuO_2-UO_2, preparation by sol-gel process
—PuO_2-UO_2, fabrication of sol-gel-derived
REACTOR FUEL ELEMENTS—performance of clad oxide
—burnup studies on oxide
—shipment of spent LMFBR, cask studies for
—reprocessing of clad oxide, sodium removal in head-end
—reprocessing of, voloxidation process for fission product removal in head-end
REACTOR FUELS—reprocessing of LMFBR, research progress (June 1971) on aqueous
—performance of oxide
SODIUM—removal from spent LMFBR fuel elements
URANIUM OXIDES UO_2—preparation from solutions from fuel reprocessing cycle
—preparation of sols of, CUSP process for
—PuO_2-UO_2, radiation effects on sol-gel-derived (M.C.G.)

47936 (ORNL-TM-3527) HTGR HEAD-END PROCESSING: A PRELIMINARY EVALUATION OF PROCESSES FOR DECONTAMINATING BURNER OFF-GAS. Glass, R. W.; Haas, P. A.; Lowrie, R. S.; Whatley, M. E. (Oak Ridge National Lab., Tenn.). Jul 1972. Contract W-7405-eng-26. 58p. Dep. NTIS.

The off-gas from burning irradiated High-Temperature Gas-Cooled Reactor (HTGR) graphite fuel blocks must be decontaminated before CO_2 and the other components are discharged to the environment. A literature search and preliminary evaluation of processes were made for separation and concentration of ^{85}Kr from gas composed mainly of CO_2 (>90%) but also containing small fractions of O_2, N_2, and perhaps CO. In order of preference, the most promising of the processes reviewed were found to be: krypton absorption in liquid CO_2 (KALC), controlled solidification of CO_2 (CSC), hot potassium carbonate absorption of CO_2 (HPC), and simple distillation of liquid CO_2 (DLC). The KALC process is the only one of the four that accomplishes the separation of Kr from both the less-volatile CO_2 and the more-volatile gases (O_2, N_2, CO). The primary uncertainty in each of the four processes is the distribution coefficient for Kr between the gaseous phase and the condensed phase. The experimental studies required for further evaluation and development are outlined. (42 references) (auth)

47937 (ORNL-TM-3571) LMFBR FUEL CYCLE STUDIES PROGRESS REPORT FOR AUGUST 1971, NO. 30. (Oak Ridge National Lab., Tenn.). Sep 1971. Contract W-7405-eng-26. 47p. Dep. NTIS.

FISSION PRODUCTS—volatilization from spent oxide fuels
IODINE—separation from fuel reprocessing off-gases
—separation from air by sorption on solids
—separation from tritium as tritiated water by sorption on molecular sieves
—separation from air by trapping using nitric acid, Iodex Process for
LIQUID METAL FAST BREEDER REACTOR—fuel cycle development studies (August 1971) on
METHANE, IODO—separation from air by sorption on solids
REACTOR FUEL ELEMENTS—shipment of spent LMFBR, cask studies for
—storage of spent LMFBR
—reprocessing of oxide, voloxidation process for fission product removal in head-end
—performance of clad oxide
—burnup analysis of oxide
—thermal conductance of fuel-to-cladding gap in oxide
REACTOR FUELS—performance of oxide
—reprocessing of LMFBR, research progress (August 1971) on aqueous
TRITIUM—separation as tritiated water from iodine by sorption on molecular sieves
URANIUM OXIDES UO_2—PuO_2-UO_2, dissolution in nitric acid
—PuO_2-UO_2, fabrication of sol-gel-derived
—PuO_2-UO_2, radiation effects on
WATER—separation from iodine by sorption on molecular sieves (M.C.G.)

47938 (ORNL-TM-3614) LMFBR FUEL CYCLE STUDIES PROGRESS REPORT FOR SEPTEMBER 1971, NO. 31. (Oak Ridge National Lab., Tenn.). Oct 1971. Contract W-7405-eng-26. 55p. Dep. NTIS.

FISSION PRODUCTS—volatilization from oxide fuels
IODINE—separation from fuel reprocessing off-gases by trapping using nitric acid, Iodex process for
—separation from tritium as tritiated water by sorption on molecular sieves
IODINE-131—exchange between gaseous iodine and iodine compounds dissolved in nitric acid
LIQUID METAL FAST BREEDER REACTOR—fuel cycle development studies (Sept. 1971) for
METHANE, IODO—separation from air by sorption on solids
PLUTONIUM OXIDES PuO_2—PuO_2-UO_2, fabrication of sol-gel-derived
REACTOR FUEL ELEMENTS—performance of clad oxide
—shipment of spent LMFBR, cask studies for
—reprocessing of, removal of fission products in head-end
REACTOR FUELS—reprocessing of LMFBR, research progress (Sept. 1971) on
—dissolution of oxide, in nitric acid
—reprocessing of oxide, Iodex process for iodine removal from off-gases from
SODIUM OXIDES—reactions with uranium dioxide
THORIUM OXIDES ThO_2—ThO_2-UO_2, dissolution in nitric acid
TRITIUM—separation as tritiated water from iodine by sorption on molecular sieves
URANIUM OXIDES UO_2—PuO_2-UO_2, radiation effects on, tests for studies on
—$CeO-UO_2$, dissolution in nitric acid
—reactions with sodium oxides
WATER—separation from iodine in off-gases by sorption on molecular sieves (M.C.G.)

47939 (SC-R-722770(Vols.1-4)) FUSED SALTS, A BIBLIOGRAPHY. VOLUME I. CITATIONS LISTING. VOLUME II. SYMBOLS AND FORMULAE. VOLUME III. DESCRIPTIVE TERMS. VOLUME IV. AUTHORS INDEX. Schalit, Michael (comp.). (Sandia Labs., Albuquerque, N. Mex.). Jul 1972. 1287p. Dep. NTIS.

These volumes are issued separately but cataloged as a unit. This publication incorporates the bibliographic data given in reference numbers 7001-7380 of SC-R-71-3315 (Fused Salts, A Bibliography) and additional citations compiled from the Chemical Abstracts through March, 1972. It provides supplementary access points—chemical symbols and formulae, subject and descriptive terms—as well as author. (auth)

47940 SEPARATION OF URANIUM, THORIUM AND PROTACTINIUM BY EXTRACTION WITH TERTIARY AMINES FROM MIXED MEDIA. Alian, A.; Born, H.-J.; Staerk, H. (Technische Univ., Munich). Radiochim. Acta; 17: No. 1, 49-51(May 1972).

The separation of ^{234}Th(UX$_1$) and ^{234}Pa(UX$_2$) from uranyl salt by extraction with trioctylamine solution from 4.8 M HCl was studied in pure aqueous and in mixed media. The presence of ethanol or acetone decreased the number of stages required for separation and purer products are obtained. (auth)

47941 PROCESS FOR SEPARATING THE CORE OF A TUBULAR NUCLEAR FUEL ELEMENT. Van Impe, Jean; Chaussonnet, Pierre E.; Rombaux, Jean-Pierre M. (to ENI-L'Electro-Navale and Industrielle. SEPI). U. S. Patent 3,679,378. 25 Jul 1972. Priority date 10 Jul 1968, Belgium.

The electrically conductive outer cladding of a tubular element is separated from the inner core of the element by cutting the cladding electrochemically using an electrolyte and simultaneously leaching the core material out of the cladding by means of the electrolyte. The electrode used to effect the electrochemical cutting may be hollow and the electrolyte passed through it under pressure. The electrolyte may be of a nature that dissolves the core material. A screen beneath the tubular element catches empty cut sections of the element but allows the electrolyte and the core material to pass through for collection. (Official Gazette)

ENGINEERING

Energy Conversion

Refer also to abstracts 47986 and 48379.

47942 (AD–733081) PRACTICAL ASPECTS OF FUNDAMENTAL RESEARCH IN THERMIONIC CONVERSION. Summary Technical Report, September 1, 1970–October 31, 1971. Rasor, Ned S.; Britt, E. J. 30 Nov 1971. Contract N00014-70-C-0252. 48p. (NSR–1-3). NTIS.

The report summarizes the results of the past year in a continuing effort to utilize basic converter research for practical improvement of engineering designs. Experimental results are presented which were obtained with an argon discharge used as an experimental analog for a cesium vapor system. Attempts to suppress the power lost in the arc voltage drop are described. An auxiliary discharge triode was investigated in the argon system. A more extensive study of arc drop suppression by pulse enhancement was carried out for both argon and cesium diodes. A theoretical correlation is presented which allows the emitter temperature in a converter to be determined from the J–V characteristic. An analytical description of the adsorption phenomenology for cesium and oxygen on tungsten is presented. The features of the analysis are generally applicable to adsorbate-substrate systems with both monatomic and diatomic molecules. (auth) (NTIS)

47943 (AD–738495) ELECTRODE EFFECTS AND GAS-DYNAMIC CHARACTERISTICS OF A LARGE, NONEQUILIBRIUM MHD GENERATOR WITH CESIUM SEEDED, NOBLE GASES. Zauderer, B.; Tate, E. (General Electric Co., Philadelphia, Pa. Space Div.). Mar 1972. Contract N00014-70-C-0321. 36p. NTIS.

An experimental study was performed to determine the factors limiting the power output of a linear, supersonic Faraday generator, having electrodes suspended in the gas flow. The test gases were cesium seeded neon or argon at 2000 to 4000°K stagnation temperatures and 5 to 11 MW thermal power levels. It was observed that the electrode current varies directly with the cesium concentration for electrode current densities of the order of tens of A/cm.^{2} The electrode current was nearly independent of electrode temperature and surface area. It was concluded that the electrode conduction was due to the cesium ion flux at the cathode. The gas dynamic characteristics of the generator as deduced from pressure and Mach number measurements were in fairly good agreement with the theory based on the one dimensional gas conservation equations. (auth) (NTIS)

47944 (AD–801745) DEVELOPMENT OF A FOSSIL-FUEL-FIRED HEAT PIPE FOR USE WITH THERMIONIC ENERGY CONVERTERS. Summary Technical Report (Final), June 1, 1965–June 30, 1966. Hall, W. B.; Kessler, S. W. (Radio Corp. of America, Lancaster, Pa. Direct Energy Conversion Dept.). Sep 1966. Contract DA-28-043-AMC-01507(E). 125p. (ECOM–1507-F). NTIS.

The design and performance characteristics of a heat pipe for transferring heat from a fossil fuel flame to thermionic energy converters are described. A theoretical analysis of the heat pipe was performed and experimental data is used to verify the theoretical conclusions. (NTIS)

47945 (BARC–602) NUCLEAR POWER IN AGRICULTURAL DEVELOPMENT. Sarabhai, Vikram; Thomas, K. T. (Bhabha Atomic Research Centre, Bombay (India)). 1972. 11p. (CONF-711143–1). Dep. NTIS (U. S. Sales Only).

From Seminar on use of isotopes and radiation in agriculture and animal husbandary research; New Delhi, India (30 Nov 1971).

Programs for developing dual purpose plants to produce power and desalinated water in India are discussed. The power generated could be used in agriculture to produce fertilizer and to pump irrigation water from large underground reservoirs. Future studies under consideration include: development of a prototype desalination plant based on a combined Long Tube Vertical Evaporator and Multistage Flash Distillation (LTVE-MSF) desalination process; evaluation of the water requirements for crops at specific sites; hydrologic research to determine the location and size of underground water reservoirs; and evaluation of equipment and methods for producing fertilizers. (L.C.L.)

47946 (CONF-710444–9) UTILIZATION OF HIGH TEMPERATURE NUCLEAR HEAT IN THE CHEMICAL AND IRON AND STEEL INDUSTRIES. Siebker, M.; Martin, H. (European Communities, Brussels (Belgium). Commission). Mar 1971. 30p. (In French). Dep. NTIS (U. S. Sales Only).

From International conference on chemical sciences; Paris, France (20 Apr 1971).

The possible uses of nuclear heat produced by HTGR in the production of basic chemical materials such as hydrogen or the synthesis gas, in a mixed nuclear-fossil fuel system, or in the direct reduction of iron ores are examined. A nuclear complex for iron and steel industry is envisaged in which a HTGR supplies the energy necessary for the three stages involved in the production of crude steel. (France)

47947 (HEDL-SA–327) METHODS OF CALCULATION FOR NATURAL DRAFT COOLING TOWERS. Keyes, R. E. (Westinghouse Hanford Co., Richland, Wash. (USA)). 30 Dec 1971. Contract AT(45-1)-2170. 30p. (CONF-720434–1). Dep. NTIS.

From thirteenth national heat transfer conference; Denver, CO. (6 Aug 1972).

Parametric relations between mechanical and natural draft wet cooling towers were investigated. Results of the investigation are applicable to the development of preliminary natural draft cooling tower design based on cooling load requirements and atmospheric conditions. The relationships can also be used in evaluation of tower performance. (J.R.D.)

47948 (HIT–503) Ni/ZrO$_2$ HIGH TEMPERATURE THERMAL SWITCH PROGRAM. Final Report, February 1971–July 1971. (Hittman Associates, Inc., Columbia, Md.). Aug 1971. Contract AT(29-2)-2797. 52p. Dep. NTIS.

Activities in a program to design, develop, and test thermal switch materials to operate at 1200 to 1300°C in conjunction with Pioneer RTG heat source are reported. Information is included on materials selection, fabrication of composite materials, property determination, and Ni sublimation. (J.R.D.)

47949 (MND–2050-F-3(Vol.3)) STUDY FOR 250-WATT CONTROLLED REENTRY ORBITING NUCLEAR SYSTEM. VOLUME III. DEVELOPMENT PROGRAM PLAN. (Martin Co., Baltimore Md.). 2 Nov 1966. Contract AT(29-2)-2050. 310p. Dep. NTIS.

Declassified 2 Nov 1971.

47950 (MND–2050-F-4(Vol.4)) STUDY FOR 250-WATT CONTROLLED REENTRY ORBITING NUCLEAR SYSTEM. VOLUME IV. SPECIFICATIONS AND DATA MANAGEMENT. (Martin Co., Baltimore, Md.). 2 Nov 1966. Contract AT(29-2)-2050. 177p. Dep. NTIS.

Declassified 2 Nov 1971.

47951 (MND–3296-1) FEASIBILITY OF ISOTOPIC POWER FOR MANNED LUNAR MISSIONS. VOLUME 1. SUMMARY. (Martin Marietta Corp., Baltimore, Md. Nuclear Div.). May 1964. Contract AT(30-1)-3296. 56p. Dep. NTIS.

Declassified 2 Nov 1971.

47952 (MND–3296-3) FEASIBILITY OF ISOTOPIC POWER FOR MANNED LUNAR MISSIONS. VOLUME 3. THERMOELECTRIC SYSTEM. (Martin Marietta Corp., Baltimore, Md. Nuclear Div.). May 1964. Contract AT(30-1)-3296. 70p. Dep. NTIS.

Declassified 2 Nov 1971.

47953 (MND–3296-4) FEASIBILITY OF ISOTOPIC POWER FOR MANNED LUNAR MISSIONS. VOLUME 4. THERMIONIC SYSTEM. (Martin Marietta Corp., Baltimore, Md. Nuclear Div.). May 1964. Contract AT(30-1)-3296. 29p. Dep. NTIS.

Declassified 2 Nov 1971.

47954 (MND–3296-5) FEASIBILITY OF ISOTOPIC POWER FOR MANNED LUNAR MISSIONS. VOLUME 5. BRAYTON CYCLE SYSTEM. (Martin Marietta Corp., Baltimore, Md. Nuclear Div.). May 1964. Contract AT(30-1)-3296. 75p. Dep. NTIS.

Declassified 2 Nov 1971.

47955 (MND–3296-6) FEASIBILITY OF ISOTOPIC POWER FOR MANNED LUNAR MISSIONS. VOLUME 6. STIRLING CYCLE SYSTEM. (Martin Marietta Corp., Baltimore, Md. Nuclear Div.). May 1964. Contract AT(30-1)-3296. 43p. Dep. NTIS.

Declassified 2 Nov 1971.

47956 (MND–3296-7) FEASIBILITY OF ISOTOPIC POWER FOR MANNED LUNAR MISSIONS. VOLUME 7. DOWTHERM-A RANKINE SYSTEM. (Martin Marietta Corp., Baltimore, Md. Nuclear Div.). May 1964. Contract AT(30-1)-3296. 44p. Dep. NTIS.

Declassified 2 Nov 1971.

47957 (MND–3296-8) FEASIBILITY OF ISOTOPIC POWER FOR MANNED LUNAR MISSIONS. VOLUME 8. MERCURY RANKINE SYSTEM. (Martin Marietta Corp., Baltimore, Md. Nuclear Div.). May 1964. Contract AT(30-1)-3296. 56p. Dep. NTIS.

Declassified 2 Nov 1971.

47958 (MND–3612-9) POLONIUM RADIOISOTOPE THERMOELECTRIC GENERATOR. SPECIFICATIONS. (Martin-Marietta Corp., Baltimore, Md.). Dec 1965. Contract AT(30-1)-3612. 434p. Dep. NTIS.

Declassified 2 Nov 1971.

47959 (MND–P–2612) PRELIMINARY SAFETY ANALYSIS OF THE SURVEYOR GENERATOR. SNAP Programs, Subtask 7.1. (Martin Co., Baltimore, Md. Nuclear Div.). Sep 1961. Contract AT(30-3)-217. 100p. Dep. NTIS.

Declassified 2 Nov 1971.

47960 (MND–P–2901) 250-WATT(e) ISOTOPE-FUELED THERMIONIC GENERATOR STUDY. Final Report. Kortier, W. E.; Lyon, W. C. (Martin Marietta Corp., Baltimore, Md. Nuclear Div.). Jun 1963. Contract AT(30-1)-3021. 282p. Dep. NTIS.

Declassified 2 Nov 1971.

47961 DETERMINATION OF THE WORK FUNCTION OF CESIUM COVERED SURFACES AT HIGH TEMPERATURES IN A PLANE-PARALLEL CESIUM DIODE. 1. TECHNOLOGY. Maier, E. (Univ., Stuttgart). Energy Convers.; 12: No. 3, 89-93(Sep 1972). (In German).

Design and construction of a thermionic cesium diode with plane-parallel electrodes is presented. The diode is used for measuring the work function of various emitter materials under diode operating conditions. The spacing between the exchangeable electrodes is variable and the electrodes themselves are adjustable to obtain and maintain the parallel geometry. The temperature of the tantalum emitter is measured pyrometrically through a sapphire window in a "black body" hole of the emitter. The collector is surrounded by an electrically insulated guard ring with separate electrical circuit. The collector and guard ring are water-cooled and additionally electrically heated. Thermocouples are used for measuring collector and guard ring temperatures. Primary operation of the diode was successful. Measurements were carried out in the unignited and ignited mode at emitter temperatures between 1630 and 1900°K and cesium vapor pressures between 0.5 and 6 torr. The maximum electrical power output density was 4.2 W/cm^2. (auth)

47962 DETERMINATION OF THE WORK FUNCTION OF CESIUM COVERED SURFACES AT HIGH TEMPERATURE IN A PLANE-PARALLEL CESIUM DIODE. 2. PHYSICAL PRINCIPLES AND RESULTS OF MEASUREMENTS. Maier, E. (Univ., Stuttgart). Energy Convers.; 12: No. 3, 95-101(Sep 1972). (In German).

Current–voltage characteristics were measured in the unignited mode of a plane-parallel cesium diode with a tantalum emitter. These measurements were carried out at emitter temperatures between 1700 and 1900°K and cesium vapor pressures between 0.1 and 6 torr. By comparing experimental saturation currents with a theoretical model, the average emitter work functions of tantalum covered with cesium under diode operating conditions were evaluated. An average vacuum work function of 4.6 eV is equivalent to measured work functions of the cesiated emitter. This high work function value of tantalum is explained by patch effects of the polycrystalline surface. (auth)

47963 THERMIONIC PERFORMANCE OF FLUORIDE CVD TUNGSTEN–NIOBIUM CONVERTER. Rufeh, F.; Lieb, D. (Thermo Electron Corp., Waltham, Mass.). Energy Convers.; 12: No. 3, 109-13(Sep 1972).

Parametric data was obtained from a variable-spacing converter with a fluoride tungsten emitter and a polycrystalline niobium collector for an emitter temperature range of 1600 to 2000°K and an interelectrode spacing range of 1 to 20 mils (25 to 500 μ). The performance of this converter was considerably lower than that of ⟨110⟩ preferred oriented emitters. Attempts were also made to measure the cesiated work function of the electrodes. The transient effects observed showed that, unlike other materials, the emission characteristics of this emitter depended on its temperature history preceding the test. This dependence was attributed to the diffusion of an impurity element, possibly carbon, in the fluoride tungsten material to the emitter surface. The present data indicate that the performance at low temperatures (<1800°K) would have been even lower if additives were not diffusing through the emitter. (auth)

47964 PAST AND FUTURE IN THE FRENCH ENERGY ECONOMY (1950–2000). Boiteux, M. (Electricite de France, Paris). Rev. Fr. Energ.; 24: No. 238, 174-86(Jan 1972). (In French).

The evolution in the past of the energy industries is examined, particular attention being given to sharp increases in demands, growth factors, the distribution between the different forms of energy, modifications in the organization and operation of the energy system, and the problems posed by the compatibility of the system with the environment. These factors lead to certain predictions: the increase in the total primary energy consumption together with that of electricity will be fairly rapid until the end of the century. The probable distribution of this energy between the various primary sources (oil, natural gas, and nuclear energy) are examined. The way in which an oil based economy can be transferred into a nuclear based economy and the problems arising concerning the reliability of supplies, prices and the environment are examined. (France)

Facilities and Equipment

Refer also to abstracts 48325 and 48498.

47965 (ANL/EBR–55) SODIUM AEROSOL TRAP DESIGN. EBR-II Project. Barton, Paul (Argonne National Lab., Ill. Argonne National Lab., Idaho Falls, Idaho). Mar 1972. Contract W-31-109-Eng-38. 18p. Dep. NTIS.

Based on a study of sodium aerosol trap technology, it is concluded that hot refluxing wire-mesh demisters can reduce the sodium content of argon to <2 μg/g for at least 100 days with oxygen contamination of 30 μg/g and several times longer at <10 μg/g. Compact, low-pressure-drop designs are proposed for the high-capacity EBR-II argon cooling system (21,000 cm^3/sec) and for monitoring systems requiring up to 1400 cm^3 of argon per second. Novel features include high-temperature operation for better wetting, installation of the mesh in a slanted annulus to ease return of molten sodium and to enhance heat transfer, and 25 to 50 μm wire mesh for improved interception. (auth)

47966 (BARC/I–145) PANORAMIC BATCH IRRADIATOR, TROMBAY (PANBIT). Krishnamurthy, K.; Wamorkar, R. R.; Aggarwal, K. S.; Patel, S. S.; Ramakrishnan, G.; Apte, M. G.; Datta, S. S. (Bhabha Atomic Research Centre, Bombay (India)). 1971. 28p. INIS.

The design and operation procedures for an all-purpose irradiation facility, the Panoramic Batch Irradiator, Trombay (PANBIT), built and commissioned at the Bhabha Atomic Research Center are described. The irradiator occupies a floor area of 95 square meters and is housed in a building 5 meters in height. Basically, the facility consists of a concrete biological shield and labyrinth access, irradiator chamber, source, source shield and storage pit, control room, source control drive system, and product irradiation system. The designed capacity of the irradiator is 50,000 Ci of cobalt-60 but a nominal loading of 10,000 Ci is made initially. A maximum dose of 0.5 megarads/h at a distance 17 cm from the center of the source and a minimum dose of 2 krad/h at one of the corners are obtained for a loading of 10,000 Ci of cobalt-60. The irradiator is operated remotely through a series of motor and timer controls. The facility is used to establish feasibility of any radiation process, economics of a process, and consumer acceptance of the product. It also assists in training the personnel in the operation and maintenance of irradiation facilities. (INIS)

47967 (JUL–828-RX) DEVELOPMENT OF FUEL AND STRUCTURAL MATERIAL IRRADIATION FACILITIES BY USE OF MECHANICAL ASSEMBLY PRINCIPLE. Schmidt, F. (Kernforschungsanlage, Juelich (West Germany). Zentralinstitut fuer Reaktorexperimente). Jan 1972. 41p. (In German). Dep. NTIS (U. S. Sales Only).

The feasibility of applying the modular construction principle to rigs intended for irradiation studies on nuclear fuels and structural materials was studied. It was shown that most radiation studies could be performed with a 2-in. rig. Therefore, a 2-in. modular construction rig was developed. Through this development, experience was gained about the construction of different rigs for other reactors. (H.B.G.)

47968 (ORNL–4779, pp 84-90) EXPERIMENTAL EQUIPMENT AND NEW TECHNIQUES. Apr 1972.

In Solid State Division annual progress report for period ending December 31, 1971.

BULK SHIELDING FACILITY—low-temperature irradiation facility improvements

FURNACES—development of vacuum, for outgassing niobium parts
NEUTRON SPECTROMETERS—operation of magnetically pulsed time-of-flight
ORNL RESEARCH REACTOR—long-wavelength neutron facility
SPECTROMETERS—description of combined magneto-optical dichroism and EPR (D.L.C.)

47969 (ORNL-TM-3725) VALVE FAILURE IN THE ORNL FUEL FAILURE MOCKUP LIQUID METAL FACILITY. Koger, J. W. (Oak Ridge National Lab., Tenn.). Aug 1972. Contract W-7405-eng-26. 28p. Dep. NTIS.

Examination of two valves, a $2\frac{1}{2}$-in. throttling valve and a $\frac{1}{2}$-in. drain valve, that failed and caused a sodium leak in the Fuel Failure Mockup system disclosed that both failures occurred in the bellows core. Detailed metallurgical examinations of both bellows cores were conducted. Several convolutions of the $2\frac{1}{2}$-in. valve bellows core were deformed, and two sodium leak sources were found in highly stressed areas near edge welds. Results of the examination indicate that the initial sodium leak was through a crack caused by the deformation. Sodium then reacted with air causing gross corrosion on the air side of the bellows until the leak increased to a detectable level. The failure in the $\frac{1}{2}$-in. valve was attributable to either improper formation of the first convolution or mishandling of the lower part of the bellows assembly during welding to the valve. (auth)

47970 (ORNL-TM-3909) SIMULATION OF THE VAPOR TRANSPORT BETWEEN LARGE VERTICAL TUBE EVAPORATOR BUNDLES. Model Tests of the VTE-X Vapor Duct With and Without Turning Vanes. Van Winkle, R. (Oak Ridge National Lab., Tenn.). Jun 1972. Contract W-7405-eng-26. 31p. Dep. NTIS.

Flow patterns and pressure profiles were observed in a $^1/_{15}$-scale, slab-shaped model of the VTE-X inter-effect flow passage (the vapor space above Effect 1 brine sump and in front of Effect 2 tube bundle) using air to simulate steam, and injected smoke for flow visualization. Tests were conducted with and without turning vanes at flow conditions simulating high and low levels of brine in the VTE-X to determine in advance whether or not it would be useful to test turning vanes in the VTE-X (which tests had been proposed for the Phase 2 period of VTE-X operation). Whereas during the Phase 1 VTE-X experiments duct pressure drops of three to four velocity heads (measured at the area of the minimum flow passage) had been reported, comparable pressure drops of only about 1.8 to 3.9 velocity heads were measured in the model tests; use of turning vanes reduced the pressure drop about 30% (from 1.8 to 1.3 velocity heads). Differences between the results of the VTE-X and those of the model could only be ascribed to possible differences in the relative smoothness of the flow passages (varying widths of flow stream in the VTE-X vs constant width in the model), two-phase flow in the VTE-X vs single-phase in the model, or differences in the pressure tap locations or techniques by which the pressures were measured. Recommendations were given for turning vane geometry and pressure tap locations for Phase 2 experiments. (auth)

47971 (TID-4100(Suppl.70)) ENGINEERING MATERIALS LIST. Sachs, Francis L.; Corey, Ruby L.; Gardner, Helen Lee (comps.) (Technical Information Center (AEC), Oak Ridge, Tenn.). Jul 1972. 57p. Dep. NTIS.

Twenty-two packages of engineering drawings and specifications for the following equipment are presented: Surface Debris and Oil Removal System for Stream Purification; Function Generator; Passive Crack-Detecting System; Ultra-Linear 16-Bit Digital-to-Analog Converter; Vacuum Lock for Thermal-Ionization-Source Mass Spectrometer; Solid-State Controlled-Potential Coulometers; Low-Velocity Air Gun; Facility for Iodine and Methyl Iodide Radiolysis Tests; Portable Core Tester; Beam Monitor; Coulometric Titrator; Tissue Equivalent Ionization Chamber; Multiparameter Cell Separator; Environmental Suit and Accessories; Superconducting Levitron; Portable Tritium Proportional Counter; Non-Contact Capacitance Distance Gage; Reflectometer; Digital Data System; High-Rate Direct-Coupled Preamplifier; Microcalorimeter; and Reference Pulser. A list of ten engineering reports on special devices and a subject index are also included. (L.C.L.)

47972 (TRG-Report-1409(Rev.)) SPANDE: A PRELIMINARY GUIDE TO SPACE-FRAME AND PIPEWORK ANALYSIS BY MEANS OF A GENERAL-PURPOSE COMPUTER PROGRAM. Davies, D. C.; Enderby, J. A. (United Kingdom Atomic Energy Authority, Risley (England). Reactor Group). 1972. 45p. Dep. NTIS (U. S. Sales Only).

A general-purpose program for the analysis of three-dimensional frameworks, with additional refinements for pipework systems, is being developed for use on an ICL 740 computer. The immediate objective is the analysis of structural space-frames and pipework systems by a method which allows a virtually unlimited number of redundancies, but other problems such as the analysis of certain asymmetric shell problems come within its scope. When used for pipework systems, the maximum shear stress in the pipe at each node and at the mid-point of each bend is quoted as part of the output data in addition to the internal forces and moments for each length, the displacements and rotations of each node and the reactions at each point of restraint. The members comprising the system being analyzed may be either straight or of constant curvature between nodes, provided that in the case of curved members one of the principal axes of the cross-section of the member lies in the same plane as the member. Any combination of forces, moments or displacements may be imposed at some or all of the nodes. A guide is presented to provide sufficient information to enable the program to be available for general use in its present form. Application of the program is illustrated by reference to a simple space-frame, a pipework system, and a cylindrical shell. (auth)

47973 (UR-3055-4) AEROSOL AND INHALATION STUDIES WITH SUB-MICRON SILVER AGGLOMERATES. Phalen, Robert Franklynn (Rochester Univ., N. Y. Dept. of Radiation Biology and Biophysics). 1972. 94p. Dep. NTIS.

Thesis.

An exploded wire aerosol generator was evaluated using test aerosols derived from silver wires and results were compared to existing published information on exploded wire particles. Aerosol properties relevant to inhalation studies were emphasized. Primary particles were spherical, metallic, and distributed nearly lognormally by mass (geometric standard deviation about 1.5) with count median diameters between 0.05 and 0.008 microns. The primary particle size decreased as the explosion energy per unit mass of wire was increased. Primary particles rapidly formed agglomerates of up to hundreds of spherical units but an air blast aimed at and synchronized with the wire explosion was successful in reducing agglomeration. Agglomerate aerosols with submicron aerodynamic diameters were produced by rapidly diluting the explosion zone after the air blast. Agglomerates of 0.026 micron count median diameter. Primary particles had measured specific surfaces of 16.4 m^2/gm and solubility rate constants of 10 micrograms/cm^2/day in a lung fluid simulant containing protein. The relevance of exploded wire agglomerates to inhalation studies is briefly discussed. (auth)

47974 DEVELOPMENT OF DRIVING MOTORS FOR CIRCULATING PUMPS WITHOUT STUFFING BOX USED IN THE POWER PLANT CONSTRUCTION. Picmaus, F. KSB Tech. Ber.; No. 15, 35-9(1971). (In German).

The technological experience and the state of development of wet underwater motors (LUV) for driving underwater pumps and circulating pumps driven by canned motors (LUS) are reported. These motors have no stuffing boxes. The circulating pump without stuffing box in higher power ranges (6 MW for pressurized water reactors and 12 MW for boiling water reactors) is less commonly used than the circulating pump with shaft packing in reactors. The efficiencies of these pumps are compared. (INIS)

47975 ELECTRON-BEAM FLOATING-ZONE MELTING DEVICE FOR WORKING PRESSURES IN THE RANGE OF 10^{-7} TO 15 TORR. Bas, E. B.; Hafner, P.; Latif, A. A.; Wulff, G. (Swiss Federal Inst. of Tech., Zurich). pp 643-52 of Record of the 11th Symposium on Electron, Ion, and Laser Beam Technology. /Thornley, R. F. M. (ed.). New York- Inst. of Electrical and Electronics Engineers, Inc. (1971).

From eleventh symposium on electron, ion, and laser beam technology; Boulder, Colo. (12 May 1971).

Information and discussions are included on principles of floating-zone melting using point-focus electron beams, two-beam floating-zone melting devices, electron-beam generating systems, vacuum systems, operation of melting devices at high vacuum, and operation of melting devices at torr-range vacuums. (J.R.D.)

47976 LASER WELDING: THEORY, STATUS, AND PROSPECTS. Thurber, W. C. (Union Carbide Corp., Santa Monica, Calif.). pp 665-84 of Record of the 11th Symposium on Electron, Ion, and Laser Beam Technology. /Thornley, R. F. M. (ed.). New York; Inst. of Electrical and Electronics Engineers, Inc. (1971).

From eleventh symposium on electron, ion, and laser beam technology; Boulder, Colo. (12 May 1971).

The theory of laser operation as it applies to welding is summarized. Various types of laser devices that can be used for welding are described. Applications of laser welding are discussed along with advantages, limitations, and future prospects for equipment used in this technology. (J.R.D.)

Heat Transfer and Fluid Flow

Refer also to abstracts 47944, 47947, 47969, 47970, 47975, 47976, 48367, 49798, 49830, 49833, 49834, and 50015.

47977 (AE-RL-1313) MEASUREMENTS OF VOID FRACTION IN ACTUAL AND SIMULATED TWO-PHASE FLOW CONDITIONS USING A GAMMA-RAY ATTENUATION VOID METER GAUGE. Staiti, Sergio (Aktiebolaget Atomenergi, Studsvik (Sweden)). Sep 1971. 37p. INIS.

This work was carried out in connection with the 9-rod bundle experiment, where a gamma-ray attenuation method for void fraction determination was employed. Measurements were taken on modified reduced-scale test sections, in order to select the most suitable operating conditions for a specially designed gamma-ray void meter, and to test its effectiveness. Experiments were run with air and water at atmospheric pressure in a Plexiglas loop. A scintillation crystal-photomultiplier tube assembly was chosen to detect a narrow gamma-ray beam passing through a simulated flow subchannel of a square array 9-rod bundle. The output from the detector was correlated with successive flow conditions, i.e., with the channel empty, filled with water, and containing various air–water mixtures, and the results were compared with analytical data. The principal errors inherent in the method, and in the present test facilities, were also analyzed and evaluated. Two ^{137}Cs sources with different activities (0.5 mCi and 50 mCi) were used. At a later stage, experiments were also carried out with lucite mockups simulating different void conditions in a shortened 1:1-scale 9-rod bundle. Within the envisaged purposes, the results appear to be fairly satisfactory. Further tests and more refined test facilities seem to be needed. (auth) (Sweden)

47978 (AEEW-R-789) SIMPLE BUT ACCURATE ROUND TUBE, UNIFORM HEAT FLUX, DRYOUT CORRELATION OVER THE PRESSURE RANGE 0.7 TO 17 MN/m^2 (100 TO 2500 PSIA). Bowring, R. W. (Atomic Energy Establishment, Winfrith (England)). Mar 1972. 18p. Dep. NTIS (U. S. Sales Only).

A new round tube dryout correlation was developed, containing only one equation for the whole mass velocity range and four optimized parameters at any given pressure. The four parameters are expressed as functions of pressure which could, in principle, be identified with dimensionless physical property groups. The RMS error of the correlation is 7% for the 3800 data points over the pressure range. The new equation has the same accuracy as the Macbeth–Thompson round tube correlation but is much simpler; one equation and four parameters compared to two equations and up to 15 optimized parameters at each pressure in the Macbeth-Thompson correlation. It was developed as a first stage in applying pressure corrections to dryout correlations for complex geometries. (auth)

47979 (AERE-R-6687) AIR–WATER, ANNULAR FLOW IN A HORIZONTAL TUBE. Butterworth, D. (Atomic Energy Research Establishment, Harwell (England)). Feb 1971. 56p. (CONF-710836-2). Dep. NTIS (U. S. Sales Only).

From International symposium on two-phase systems; Haifa, Israel (29 Aug 1971).

Experiments were conducted on low-pressure, air–water, annular flow in a 31.8 mm ID horizontal tube. For two flow conditions and for two distances downstream of liquid injection, the film characteristics were measured as a function of circumferential position, and liquid entrainment measurements were made in the gas core. Large variations in these measurements with circumferential position were found but the variation with length was small. The total entrainment flowrates were estimated from the sampling studies, and, by using the Hewitt model, the film flowrates were estimated from the film thickness measurements. In evaluating the Hewitt model, it was assumed that the wall shear was constant around the perimeter of the tube. The sum of the calculated film flowrate and entrainment flowrates was found to be in good agreement with the input liquid flow despite the fact that the assumption of constant shear did not appear a good one after close examination. The measurements were examined for compatibility with the various mechanisms which have been proposed for maintaining the film at the top of the tube. It was found that the results were compatible with the "secondary-flow" and "wave-spreading" mechanisms, but were incompatible with the "entrainment-deposition" mechanism. It was shown that surface tension can never be an important mechanism (on its own) for maintaining annular flow, except perhaps in extremely small diameter tubes. (auth)

47980 (CEA-CONF-2001) EXPERIMENTAL STUDY OF MIXED CORRECTION IN A PIPE. Wendling, M.; Martin, R.; Ricque, R. (Commissariat a l'Energie Atomique, Grenoble (France). Centre d'Etudes Nucleaires). [nd]. 8p. (In French). (CONF-710843-2). Dep. NTIS (U. S. Sales Only).

From 14th congress of the International Association for Hydraulic Research; Paris, France (27 Aug 1971).

Some experimental results obtained on mixed convection in a channel, utilizing sodium as the working fluid are presented. The qualitative aspect of the phenomena and the effect of the main parameters (mean velocity and width of the channel) are considered. Experimental results on turbulent flows are compared with theoretical results on laminar flows. These studies are related to sodium-cooled fast reactors. (France)

47981 (CEA-CONF-2009) TWO-PHASE FLOW TRANSIENTS AND THE STABILITY OF ONCE-THROUGH STEAM GENERATORS. Boure, J. (Commissariat a l'Energie Atomique, Grenoble (France). Centre d'Etudes Nucleaires). [nd]. 9p. (In French). (CONF-710651-1). Dep. NTIS (U. S. Sales Only).

From International conference on heat exchangers; Paris, France (16 Jun 1971).

Study of the behavior of once-through steam generators and in particular their stability (occurrence of self-sustained oscillations for example) requires calculation under transient conditions of once-through two-phase flows. Starting from the general conservation principles, including a review of the necessary assumptions and models, an ideal description of the development and use of a practical mathematical model is made. It is thus possible to introduce rationally the "constitutive laws" which are necessary for the two-phase flow description, and the concepts of "superabundant constitutive law" and of "coherence" of the mathematical model (in practice of the computer program). The conservation principles impose compatibility constraints on the various elementary models (i.e., on the constitutive equations) which have to be put in the computer program. With the assumption of one-dimensional flow, six partial different equations appear to be necessary for the transient description of two-phase flows. (auth)

47982 (CISE-R-186) MEASUREMENTS OF LIQUID VOLUME FRACTION FOR ADIABATIC TWO-PHASE TWO-COMPONENT MIXTURES FLOWING IN ANNULAR AND ROD CLUSTER CHANNELS. Alia, P.; Colombo, A.; Hassid, A.; Spadoni, B. (Centro Informazioni Studi Esperienze, Milan (Italy)); Premoli, A. (Comitato Nazionale per l'Energia Nucleare, Rome (Italy)). May 1968. 15p. INIS.

Results obtained at CISE on liquid volume fraction with vertical upward flow of two-phase two-component mixtures in adiabatic conditions are presented. The experiments were carried out under the following conditions: geometry with annuli of $D_{eq} = 0.5$, 1.0 cm and seven-rod clusters of $D_{eq} = 0.50$, 0.65, 1.22 cm; fluids with argon gas phase and liquid phase of water and ethyl alcohol; temperature from 18 to 20°C; pressure of 25 kg/cm^2; liquid density of 0.78, 1 g/cm^3; gas density from 10^{-2} to $10^{-3} \times 42$ g/cm^3; specific mass flowrate from 50 to 250 g/cm ^{2}s; and quality (by weight) from 0 to 0.80. The measurements were carried out by means of a dilation technique. (INIS)

47983 (CISE-R-303) AN INVESTIGATION ON THE BLOWDOWN OF A TANK FILLED WITH SATURATED STEAM–WATER. PART 1. EXPERIMENTS. Carzaniga, R.; Premoli, A. (Centro Informazioni Studi Esperienze, Milan (Italy)); Holtbecker, H.; Soma, E. (European Atomic Energy Community, Ispra (Italy). Joint Nuclear Research Center). Dec 1970. 13p. INIS.

The first part of an experimental investigation of the blowdown phenomena relevant to a tank filled with saturated steam and water and voided throughout apertures located at different positions is described. The work was performed in support of the safety problems analysis for the CIRENE reactor. The experimental results obtained with a 3 m^3 vessel are given. The blowdowns were investigated starting from a 51 kg/cm^2 pressure. (INIS)

47984 (COO-1723-F) CRITICAL HEAT FLUX STUDIES IN POOL BOILING AND FORCED CONVECTION. Final Report. Balzhiser, Richard E.; Barry, Robert E.; Caswell, Bruce F.; Gahman, Robert L.; Kim, Kwan Y.; Lampert, William B. (Michigan Univ., Ann Arbor. Dept. of Chemical Engineering). Oct 1971. Contract AT(11-1)-1723. 71p. Dep. NTIS.

Heat transfer to sodium in forced convection flow was studied in an annular test section at heat fluxes up to 1,659,000 Btu/h-ft.^{2} Experiment failures prevented completion of the experimental program. Three runs were completed before burnout was experienced at the above flux. Stable boiling was observed from the bayonet surface at a heat flux of 1,120,000 Btu/h-ft.^{2} The temperature profile in boiling potassium near the surface of a bayonet heater was measured. The results were in agreement with the theoretical model developed which included a thermal transport component in addition to the latent heat contribution which the hydrodynamic theory predicts. (auth)

47985 (EUR-4818) TRANSIENT HEAT CONDUCTION THROUGH HEAT PRODUCING LAYERS. Wundt, H. (European Atomic Energy Community, Ispra (Italy). Joint Nuclear Research Center). 14 Mar 1972. 78p. Dep. NTIS (U. S. Sales Only). EUR B.Fr. 100.-.

A method is described which solves the heat conduction equation by means of Laplace transform techniques. The transfer functions acting on the two arbitrary "heat source density" and "ambient temperature" inputs are developed in series of partial fractions before applying the inverse transformation. The solutions for space-mean temperatures and for temperatures at selected points are presented as the respective explicit solution plus an infinite, but in general soon trancatable series of "transient complement functions". Only the generating differential equations of these functions—linear, ordinary, first order—must still be integrated for a specific problem. The coefficients of these equations, as well as the series expansion coefficients can be computed in advance for every given set of geometrical and material data, i.e., independently of the proper temporal integration. The method is therefore particularly suitable for a code. The advantage of this method over known codes with intermeshed direct integration of the partial differential equation is that it can be coupled with other systems of ordinary differential equations. This is extremely important for nuclear reactor dynamics, where this other system is the neutron kinetics and where temperatures feedback on reactivity. Moreover, if desired accuracy can be improved by simply taking more series terms, without destroying the previously obtained results, in full contrast to usual difference techniques. One- and two-layer problems are treated for plane, cylindrical, and spherical geometries and for boundary conditions of the third kind. A certain amount of mathematics is unavoidable. Heat engineers need only use the summarized set of solutions. A number of interesting summation-formulas are included. (auth)

47986 (EUR-4838) HYDROGEN AS AN ENERGY VECTOR: NEW FUTURE PROSPECTS FOR APPLICATIONS OF NUCLEAR ENERGY. Beghi, G. (European Atomic Energy Community, Ispra (Italy). Joint Nuclear Research Center). May 1972. 20p. Dep. NTIS (U. S. Sales Only).

In view of a wider penetration of nuclear energy in the energy field and therefore of a diversification of its applications, the usefulness of an intermediary energy vector is pointed out. Therefore hydrogen is examined as to its present potential uses in future. Among the hydrogen production processes, the method of dissociation of water with a closed cycle of chemical reactions and utilizing nuclear heat seems particularly promising. (auth)

47987 (EUR-4840) MEASUREMENT OF CORRELATION PROPERTIES OF THE BUBBLE FIELD IN TWO-PHASE FLOW. Matthes, W. (European Atomic Energy Community, Ispra (Italy). Joint Nuclear Research Center). May 1972. 24p. Dep. NTIS (U. S. Sales Only).

The bubble field in a two-phase flow shows inherent statistical properties which can be described by properly defined correlation functions. These correlation functions represent the whole physics of the two-phase flow in the sense that the space-time flow pattern and the physical interactions between the bubbles, which may be partly induced by the carrier fluid, show up in the detailed structure of this function. General expressions are developed relating experimental results to the correlation function and to the individual items mentioned above. (auth)

47988 (FRNC-TH-181) BOILING OF Na UNDER FORCED CONVECTION CONDITIONS. Charlety, Paul (Grenoble Univ. (France). Faculte des Sciences). 1971. 143p. (In French). Dep. NTIS (U. S. Sales Only).

A bibliographic study demonstrated the different attitudes of research laboratories to the boiling Na problem. As a result, the Heat Transfer Laboratory orientated its investigations in two complementary directions. The development of technological facilities (development of high-performance heating elements capable of simulating the fuel pins of the reactor, and development of an electromagnetic flow measurement method) and the study of boiling. The two-phase flow of Na was studied in the heating region (core), in the recondensation region (fertile coverage), and in the self-vaporization region (nuclear protection). No serious overheating could be detected. The expulsions envisaged in the theoretical model were not observed under forced convection conditions in the case of plugging at the foot of assembly. Experiments demonstrated that the laws and correlations normally used in two-phase flow are applicable to Na. These experiments lead to a method of calculating the boiling characteristics of Na in the case of a one-dimensional fast reactor assembly in the continuous operating region. (France)

47989 (ORNL-TM-3771) MASS TRANSFER OF WATER FROM SINGLE AQUEOUS SOL DROPLETS FLUIDIZED IN A PARTIALLY MISCIBLE ALCOHOL. Clinton, Sam D. (Oak Ridge National Lab., Tenn.). Jul 1972. Contract W-7405-eng-26. 147p. Dep. NTIS.

Thesis.

During the preparation of sol-gel microspheres, droplets of the aqueous sol must be suspended or fluidized in an organic phase until enough water is extracted from the sol to cause gelation. The rate of mass transfer was investigated by fluidizing single water or thoria sol droplets in a partially miscible alcohol and measuring their diameters as a function of time. Three alcohols were studied: 2-ethyl-1-hexanol (2EH), 2-methyl-1-pentanol (2MP), and n-hexanol (nH). The first alcohol was studied at 25, 40, and 50°C, whereas the remaining two were studied at 25°C only. The water solubility of the alcohols varied between 20 and 54 mg per cc, and the Schmidt numbers for these systems ranged between 5,000 and 36,000. In the majority of the runs, Ethomeen S/15, a surface-active agent, was added to the organic phase to produce a rigid liquid drop with no induced circulation. The sphere Reynolds number varied from 0.2 to 30. By relating the tangential velocity gradient at the drop interface to the sphere drag coefficient, the following expression for the Sherwood number was derived and then confirmed experimentally for both water and sol drop data: $N_{Sh} = 0.99\ N_{Re}^{0.417}\ N_{Sc}^{0.333}$. The common correlation for the fluidized water and sol drops verifies that the rate-controlling mass transfer resistance is in an organic-phase film surrounding the aqueous droplets. An explicit relationship for the mass transfer coefficient was shown to be independent of the drop diameter, and an expression was obtained to predict the gelation times of thoria sol droplets from known sol and solvent properties. Ten runs were made in which single water drops were fluidized at 25°C in 2EH containing no surfactant. Over a sphere Reynolds number range of 1 to 13, the mass transfer data for the fully-circulating drops were correlated by the following equation: $N_{Sh} = 114\ N_{Re}^{0.57}$. (auth)

47990 HEAT PIPES IN THE MAGNETIC-FIELD ENVIRONMENT OF A FUSION REACTOR. Carlson, G. A. (Univ. of California, Livermore); Hoffman, M. A. J. Heat Transfer; 94: No. 3, 282-8(Aug 1972).

Heat pipes have been proposed for use in environments where there are strong magnetic fields such as in controlled fusion reactors. The presence of a magnetic field can influence the performance of a heat pipe significantly, depending on the heat-pipe geometry, its orientation in the magnetic field, the heat-pipe materials and fluid properties, as well as the magnetic-field strength. A liquid-metal heat pipe, specifically designed to operate in a magnetic field, will employ a compound wick structure with the optimum liquid-flow passage size larger and the vapor flow passage proportionately smaller than for the no-magnetic-field design. The basic conclusion is that the presence of a magnetic field always results in a lower maximum heat-flux capability, but the detrimental effects of the magnetic field can be greatly reduced by using a heat-pipe geometry optimized for operation in the specific magnetic-field environment. (auth)

47991 VAPORIZATION OF SUPERHEATED SODIUM IN A VERTICAL CHANNEL. Singer, Ralph M.; Holtz, Robert E. (Argonne National Lab., Ill.). J. Heat Transfer; 94: No. 3, 300-4(Aug 1972).

Measurements of the vapor growth patterns and rates following the nucleation of superheated sodium in a vertical rectangular channel are presented and discussed. The vapor was found to grow as a single bubble for incipient bulk-liquid superheats greater than about 10°C, and this single bubble tended to completely fill the channel cross section (except for a thin liquid film on the walls) and to grow as a vapor slug for incipient bulk-liquid superheats greater than about 50°C. The temperature gradients in the liquid both normal and parallel to the channel axis prior to nucleation were found to have an important effect upon the dynamics of the vapor slug. Experimental data on the vapor growth and collapse rates and the associated pressure transients are presented for boiling pressures up to 1 atm and incipient superheats up to about 180°C. (auth)

Materials Testing

47992 (CONF-720806-1) EXPERIMENTALLY DETERMINED SHAPE FACTORS FOR DEEP PART-THROUGH CRACKS IN A THICK-WALLED PRESSURE VESSEL. Derby, Roger W. (Oak Ridge National Lab., Tenn.). 1972. 15p. Dep. NTIS.

From sixth national symposium on fracture mechanics; Philadelphia, PA. (28 Aug 1972).

Fracture mechanics shape factors for two series of part-through cracks in thick-walled epoxy pressure vessels were determined experimentally and compared with theoretical estimates. (auth)

47993 (INIS-mf-210) GAMMA RADIOGRAPHY. Langley, R. (Radiochemical Centre, Amersham (England)). 1971. 41p. INIS.

The fundamentals of radiography are briefly discussed and the differences arising from the use of a radioisotope rather than an x-ray machine as the radiation source are described. The required equipment is described in detail, including costs. Safety regulations are reproduced. (UK)

47994 (RD/B/N-2013) CONSTANT STRESS INTENSITY FACTOR FATIGUE CRACK PROPAGATION TESTING: DEVELOPMENT OF APPARATUS AND PRELIMINARY RESULTS. Jerram, K. (Central Electricity Generating Board, Berkeley (England). Berkeley Nuclear Labs.). Aug 1971. 13p. Dep. NTIS (U. S. Sales Only).

Automatic systems for following the progress of a fatigue crack and for carrying out constant stress intensity factor fatigue tests were developed for use in conjunction with a servo-hydraulic fatigue testing machine. The systems described are capable of carrying out tests at either constant cyclic load or constant cyclic stress intensity factor combined with either constant mean load or constant mean stress intensity factor. (auth)

47995 NONDESTRUCTIVE TESTING OF ADVANCED COMPOSITES. Anderson, Robert T.; DeLacy, Thomas J. (General Dynamics, San Diego, Calif.). Metal Progr.; 102: No. 2, 88-92 (Aug 1972).

Of the various nondestructive tests applied to resin-matrix and metal-matrix composites, radiographic and ultrasonic tests have proved most beneficial so far. Sensitivity must be relatively high, approaching current state-of-art thresholds. Since the complex internal structure of composites causes much background noise at these very high sensitivities, methods of noise suppression and image enhancement are highly desirable. It was also found that high-contrast radiography proved to be useful for routine testing of metal-matrix and thin resin-matrix composites. Microradiography has been used during development phases to aid fracture analysis and to observe defects under load. The transmission-reflection method of ultrasonic testing detects open bonds between matrix layers very well. However, the method is only effective for testing fairly thin sections of uniform cross section. Thermal methods work well for finding interlaminar defects and measuring resin ratios of resin-matrix composites. Such methods are not reliable for testing metal-matrix composites, however. Eddy current methods are effective for measuring volume-fractions on metal-matrix material, but have limited application for defect detection. Methods which should be investigated include holography and stress-wave acoustic emission. Vibrational methods, particularly those which can be confined to small areas, may also prove useful. Data analysis and display techniques require immediate attention. Computers and other mechanical electronic devices might be integrated with testing and inspection equipment to facilitate testing. (auth)

Nuclear Explosions

Refer also to abstracts 47687, 48070, 48144, 49319, and 49654–49656.

47996 (AD-737770) PRESHOT GEOLOGICAL AND ENGINEERING CONDITIONS AT THE PROJECT FLIVVER SITE, NEVADA TEST SITE. Final Report. Carter, Louis D.; Bailey, Duryl M.; Hunt, Richard W. (Army Engineer Waterways Experiment Station, Vicksburg, Miss.). May 1967. 63p. NTIS.

The site of the Flivver experiments is in basalt on the central ridge of Buckboard Mesa, Nevada Test Site. A soil layer averaging 2 ft thick covers the site. The basalt, which is about 237 ft thick at the Flivver site, can be divided into three units: an upper, vesicular unit; a middle, dense unit; and a thin, basal vesicular unit. Deformation of vesicles and concentration of vesicles into layers during viscous flowage have imparted a pronounced layering to the basalt. The orientation of these layers indicates that the major structure of the ridge is cylindrical. Minor folding in the upper portion of the flow complicates this structure. The trend of the ridge and the attitudes of flow layers indicate that the flow curved eastward as it flowed south-southeast across the site. (auth) (NTIS)

47997 (AD-737772) CHUKAR MESA INVESTIGATION; EXPLORATION OF AREAS FOR A POSSIBLE HARD-ROCK CRATERING SITE. Final Report. Lutton, Richard J.; Hunt, Richard W. (Army Engineer Waterways Experiment Station, Vicksburg, Miss.). Jun 1967. 63p. NTIS.

A site in dry basalt was selected from six possible areas at the Nevada Test Site for a low-yield nuclear row-charge cratering experiment. Topography is relatively flat over an approximately square area about 3,000 ft across; the area is bounded on three sides by canyons. The site consists of about 330 ft of horizontal basalt flows resting on tuff breccia, other basalt flows, and a thick vitrophyric flow. Unconfined compressive strengths on intact materials tend to decrease with increasing porosity from 23,000 psi for dense basalt to 6,200 psi for vesicular basalt with 20 to 30% vesicles. The porous tuff breccia has compressive strengths as low as 1,100 psi. (auth) (NTIS)

47998 (AD-738139) MIDDLE COURSE I CRATERING SERIES. Technical Report, July–December 1970. Fitchett, Donald J. (Army Engineer Nuclear Cratering Group, Livermore, Calif.). Jun 1971. 57p. (NCG-TR-35). NTIS.

During the period from Aug. to Nov. 1970, the U. S. Army Engineer Nuclear Cratering Group conducted Project Trinidad, an extensive series of 1-ton single- and row-charge cratering experiments near Trinidad, Colorado. As part of Project Trinidad the Defense Atomic Support Agency (DASA) sponsored the MIDDLE COURSE series of four surface and two optimum depth cratering experiments. The cratering results of the DASA MIDDLE COURSE series combined with the results of the Project Trinidad tests provided the complete cratering curve for sandstone media. (auth) (NTIS)

47999 (ARLV-351-26) WEATHER PREDICTIONS AND SURFACE RADIATION ESTIMATES FOR THE CANNIKIN EVENT. Final Report. Armstrong, Robert H.; Quinn, Virgil E. (National Oceanic and Atmospheric Administration, Las Vegas, Nev. Air Resources Lab.). Jul 1972. Contract SF 54-351. 52p. Dep. NTIS.

For Nevada Operations Office (AEC), Las Vegas.

For CANNIKIN, event-oriented forecasts of winds, weather, vertical atmospheric stability, and air trajectories were presented to the Test Manager and his Advisory Panel in frequent formal and informal briefings beginning at D-8 days. Because the possible, though unlikely, release of radioactivity into the atmosphere was recognized, estimates of potential radiation effects were also presented during the briefings. Concurrent with arrival of the nuclear device, routine weather forecasts for the Amchitka area were issued twice daily to aid in planning preparatory activities and for use in case of nuclear accident. On D-Day, intensive surveillance of changing meteorological conditions at the surface and aloft throughout the western Aleutian Islands was maintained by means of frequent weather observations at Shemya, Amchitka, and Adak. The Test Manager and his Advisory Panel were kept informed of the interpretation of these observations starting with the final readiness briefing and continuing throughout the day. D-Day meteorological data are included in the report. Three surface wind towers were installed and instrumented on Amchitka Island. A 24-hr weather observing station equipped to take upper-air soundings (wind, temperature, pressure, and humidity) as well as surface observations was in operation at the Northwest Camp for ten weeks preceding the event. Communications facilities were acquired for receiving large-scale meteorological data and forecasts for the North Pacific Ocean area from the major forecast centers. (auth)

48000 (CGS-746-132) ALEUTIAN SEISMIC PROGRAM SEISMOLOGICAL BULLETIN, MARCH 1972. (National Oceanic and Atmospheric Administration, Rockville, Md. Environmental Research Labs.). Jun 1972. Contract AT(29-2)-746. 93p. Dep. NTIS.

The purpose of this bulletin is to collect and distribute preliminary data acquired from an aleutian network of seismic stations in order to facilitate current studies of earthquake occurrence in the Aleutian Islands. Record arrival times and amplitudes were scaled by the Special Projects Party, Las Vegas, Nevada. Final reduction and collation of data to event hypocenters and derivation of related parameters were performed by the seismology investigations group, Rockville, Maryland. This compilation is preliminary and may be subject to later revision on the basis of current research. (auth)

48001 (CGS-746-133) ALEUTIAN SEISMIC PROGRAM SEISMOLOGICAL BULLETIN: MILROW SEISMIC EFFECTS. (National Oceanic and Atmospheric Administration, Rockville, Md. Environmental Research Labs.). Jun 1972. Contract AT(29-2)-746. 85p. Dep. NTIS.

The purpose of this bulletin is to collect and distribute preliminary data acquired from an Aleutian network of seismic stations in order to facilitate current studies of earthquake occurrence in the Aleutian Islands. Record arrival times and amplitudes were scaled by the special projects party, Las Vegas, Nevada. Final reduction and collation of data to event hypocenters and derivation of related parameters were performed by the seismology investigations group, Rockville, Maryland. This compilation of data on the Milrow seismic effects is preliminary and may be subject to later revision on the basis of current research. (auth)

48002 (CGS-746-134) ALEUTIAN SEISMIC PROGRAM SEISMOLOGICAL BULLETIN: CANNIKIN SEISMIC EFFECTS. (National Oceanic and Atmospheric Administration, Rockville, Md. Environmental Research Labs.). Jun 1972. Contract AT(29-2)-746. 198p. Dep. NTIS.

The purpose of this bulletin is to collect and distribute preliminary data acquired from an aleutian network of seismic stations in order to facilitate current studies of earthquake occurrence in the Aleutian Islands. Record arrival times and amplitudes were scaled by the Special Projects Party, Las Vegas, Nevada. Final reduction and collation of data to event hypocenters and derivation of related parameters were performed by the Seismology Investigations Group, Rockville, Maryland. This compilation of data on the Cannikin seismic effects is preliminary and may be subject to later revision on the basis of current research. (auth)

48003 (FOA-4-4499) USSR EXPLOSION IN WESTERN KAZAKH, DECEMBER 23, 1970. Event Report No. 3. (Hagfors Observatory, Stockholm (Sweden)). Jul 1972. 27p. Dep. NTIS (U. S. Sales Only).

Seismic data obtained at the Hagfors Observatory in Sweden from a USSR explosion in Western Kazakh on Dec. 23, 1970 is reported. The recorded short- and long-period signals, their spectra, and the surface wave dispersion curves are presented. (auth)

48004 (JAB-99-49) DYNAMIC RESPONSE CHARACTERISTICS OF ONE-STORY TEST STRUCTURES. Scholl, R. E.; Farhoomand, I. (Blume (John A.) and Associates Research Div., San Francisco, Calif.). Jul 1972. Contract AT(26-1)-99. 70p. Dep. NTIS.

The results are presented of forced vibration tests and analytical studies conducted on simulated residential buildings located on the Atomic Energy Commission's Nevada Test Site in southern Nevada. Observed dynamic response characteristics for the buildings, including fundamental mode periods, damping, characteristic shapes, and static building stiffness values, are given. The development of a three-degree-freedom discrete mass model for analytically simulating the dynamic response behavior of these buildings is also provided. Finally, the results are presented of a parameter study using the three-degree-freedom model that shows the effects of varying soil and structure stiffnesses on fundamental mode periods and characteristic shapes for these types of buildings. The more significant conclusions of the study are that the structures tested dynamically simulate low-rise (residential) building construction, and the dynamic response behavior of low-rise buildings can be analytically approximated reasonably well. (auth)

48005 (NP-19400) RECORDED AND PROCESSED SEISMIC DATA FROM THE 1971 SAN FERNANDO EARTHQUAKE AND AFTERSHOCKS BY THE NEVADA SPECIAL PROJECTS PARTY. Bayer, Kenneth C.; King, Kenneth W. (National Oceanic and Atmospheric Administration, Boulder, Colo. Environmental Research Labs.). Jun 1972. 36p. (NOAA-TR-ERL-235-ESL-20). GPO $0.45.

Within 24 h of the occurrence of the Feb. 9, 1971 San Fernando earthquake in California seismic equipment was deployed to the area by the Earth Sciences Laboratory Special Projects Party from Las Vegas, Nev. Fifteen separate studies were conducted to determine: epicentral locations; earthquake effects on structures including buildings and dams; alluvium amplification; aftershock count; and building-soil interaction. The recorded and processed seismic data obtained in each of these studies are presented. (L.C.L.)

48006 (NVO-48(Rev.2)) REVIEWS TO INSURE SAFETY OF NUCLEAR OPERATIONS. (Holmes and Narver, Inc., Las Vegas, Nev. On-Continent Test Div.). Jul 1972. 15p. Dep. NTIS.

The activities of the Nevada Operations Office (NV) of the USAEC in carrying out its responsibility for public safety for all US nuclear tests are described. These activities include pre-shot investigations and safety predictions, handling and emplacement of the explosives, detonation, and post-shot effects evaluation. Tabulated data are presented which show the name, responsibilities, corporate membership, and review activities of the safety organizations involved in nuclear tests and the individuals from the various corporate members who are responsible for particular aspects of the NV effects evaluation program. (L.C.L.)

48007 (NVO-117) TATUM SALT DOME TEST SITE, LAMAR COUNTY, MISSISSIPPI. Site Status Report at Decommissioning, June 30, 1972. (Nevada Operations Office (AEC), Las Vegas). Jul 1972. 64p. Dep. NTIS.

Activities related to the decommissioning of the Tatum Salt Dome Test Site in Lamar County, Mississippi and the geologic and hydrologic conditions at the site on the effective date of decommissioning, 30 June 1972, are described. (L.C.L.)

48008 (NVO-746-3) SEISMICITY OF THE SOUTHERN NEVADA REGION, DECEMBER 22, 1971 TO JULY 1, 1972. Bayer, Kenneth C. (National Oceanic and Atmospheric Administration, Las Vegas, Nev. Earth Sciences Labs.). Jul 1972. Contract AT(29-2)-746. 27p. Dep. NTIS.

A cooperative network of twenty-three seismic velocity stations is operated in the southern Nevada area; the stations are monitored by the NOAA/ESL Nevada Special Projects Party located in Las Vegas, Nevada. Data from the stations are analyzed and programmed through the Computer Sciences Corporation CDC 6400 Computer, also located in Las Vegas. The most significant and active seismic activity was the Silent Canyon Sequence (areas 19 and 20) on the Nevada Test Site. A map showing the principal earthquake and aftershocks is given and discussed. This is the initial seismic bulletin in which the entire data analysis (including the computer programming) has been accomplished in Las Vegas by the Nevada Special Projects Party. The output is listed in the Hypocenter Summary. The listing is the result of data scaled only from the local network and solutions determined by a local epicenter program. A total of 296 epicenters is listed. (auth)

48009 (NVO-746-TM-3) EARTHQUAKES RECORDED BY A SEISMOGRAPH NETWORK LOCATED IN THE SOUTHERN NEVADA REGION, JANUARY 1-DECEMBER 22, 1971. Bayer, Kenneth C.; Mallis, Robert R.; King, Kenneth W. (National Oceanic and Atmospheric Administration, Las Vegas, Nev. Earth Sciences Lab.). May 1972. Contract AT(29-2)-746. 41p. (NOAA-TM-ERL-ESL-16). Dep. NTIS.

A cooperative network of twenty seismic stations is operated in the southern Nevada area; the stations are recorded by the NOAA/ESL Special Projects Party located in Las Vegas, Nevada. Data from the stations are analyzed by the Special Projects Party staff. Seismic data for the period January 1 to December 22, 1971 were processed by a CDC 6600 computer. The output is listed in the Hypocenter Summary. The listing includes solutions determined by a local epicenter location program and also solutions obtained by the National Earthquake Information Center (NEIC). More than 550 epicenters are listed. About 250 of these epicenters are located within 200 km from Station CPX, which is approximately in the center of the network. Two earthquakes and several of their aftershocks were felt in southern Nevada during 1971. Maps showing the epicenters of the two earthquakes and their aftershocks are given in this memorandum. (auth)

48010 (PNE-RB-9) PROJECT RIO BLANCO. STRUCTURAL RESPONSE STUDIES. (Medearis (Kenneth) and Associates, Fort Collins, Colo. (USA)). Jul 1971. 49p. Dep. NTIS.

Project Rio Blanco is a proposed nuclear event involving the simultaneous detonation of 3 – 30+ kiloton devices at depths of 5903, 6325, and 6747 ft below the ground surface. The event location is on Fawn Creek in Township 3 South, Range 98 West, Section 14, Rio Blanco County, Colorado. Stimulation of natural gas production is the primary objective. The ground motion resulting from the detonation is predicted to create a number of potential hazards including human injury, damage to residential, industrial, and hydraulic structures, and slope instability resulting in possible rock fall and/or landslides. Comments concerning personnel evacuation, pertinent structural response analysis results, conclusions and recommendations, locations in the Project Rio Blanco area having apparent slope stability problems, and an estimate of the cost of repairing event-associated damage are presented. (auth)

48011 (PNE-RB-10) PROJECT RIO BLANCO. STRUCTURAL RESPONSE STUDIES: RESPONSE CALCULATIONS. (Medearis (Kenneth) and Associates, Fort Collins, Colo. (USA)). Aug 1971. 69p. Dep. NTIS.

Project Rio Blanco is a proposed nuclear event involving the simultaneous detonation of 3 – 30+ kiloton devices at depths of 5903, 6325, and 6747 feet below the ground surface. Its primary objective is the stimulation of natural gas production. The geodetic coordinates of the proposed emplacement well are 39° 47′ 34.8″ North Latitude and 108° 21′ 59.6″ West Longitude, with detonation currently scheduled in 1972. Structural response calculations are presented. Mode superposition and step-by-step numerical integration procedures were utilized for the dynamic analyses. The differential equation defining the response of a multi-degree-of-freedom structure is known to be $\bar{M}\ddot{Y} + \bar{C}\dot{Y} +$

$\bar{K}\,\dot{Y} = \bar{F}_t$, where $\bar{M}$, $\bar{C}$, $\bar{K}$, and $\bar{F}_t$ are the generalized system mass, damping, spring constant, and ground acceleration-induced, time-varying force, respectively. The use of digitized ground acceleration records has also been widely accepted for earthquake dynamics studies. The Project Rio Blanco analyses were accomplished using computer programs to solve the governing differential equation for discrete time steps, appropriately scaled Rulison accelerations being utilized as forcing functions. Damping values were varied depending on the structure being analyzed. Response results were compactly displayed using computer-generated microfilm plots. A safety factor of 2.5 was used in the response analyses and that figure occurs frequently as a multiplier in the calculations which follow. Early results were obtained using Rulison ground motions, thus a factor of 1.3 was used in some instances to achieve results for Rio Blanco. (auth)

48012 (PNE–RB–28) PLOWSHARE SEEP MODEL FOR GAS STIMULATION APPLICATIONS. Lessler, R. M.; Green, J. B. Jr.; Tewes, H. A.; Montan, D. N. (California Univ., Livermore. Lawrence Livermore Lab.). Apr 1972. 31p. Dep. NTIS.

A mathematical model is presented for calculating the gas flow from a nuclear cavity in a natural gas reservoir to the ground surface due to seepage through or near the casing grout in the explosion emplacement well. The maximum radioactivity release from an accidental leakage of this type is also calculated assuming that the rare gas (Kr and Xe) isotopes are available for release and that 1% of the direct fission yields of the radioiodine are volatile and available to the gas. The rates of flow of gas seepage calculated using this model for both the Rio Blanco and the Wagon Wheel experiments indicate that the "break-through" times for such gas flow are of the order of many days and the "steady-state" gas flow rates are typically a few thousand ft^3/d. It should be emphasized that these calculations are based on assumed maximum accident conditions and that, in fact, no seepage of gas whatsoever is expected. (L.C.L.)

48013 (PNE–WW–7) PROJECT WAGON WHEEL: NUCLEAR EXPLOSIVE STIMULATION OF A NATURAL GAS WELL. Rogers, Leo A. (El Paso Natural Gas Co., Tex.). 1972. 41p. (CONF-720205–3). Dep. NTIS.

From seventy-first national meeting of the American Institute of Chemical Engineers; Dallas, TX. (20 Feb 1972).

Wagon Wheel is an experiment being designed to stimulate a natural gas well in Sublette County, Wyoming. It involves using multiple nuclear explosives vertically spaced in a gas well and detonated sequentially so that a large vertical section of the well can be stimulated. The project is described. Information is included on the project background, location selection, description of the site, the reservoir parameters, detonation design, and the project program. Wagon Wheel will be used to evaluate the cost and practicality of nuclear stimulation of natural gas reservoirs and will provide specific information on: the effect of spacing of multiple nuclear explosives emplaced in a single well on creating a continuous rubble chimney; refinement of engineering technology of emplacing and detonating nuclear explosives and of reentry drilling and well completion; production costs and gas deliverability; chemical composition and radioactivity of the gas produced and of water and other liquids produced in association with the gas; seismic effects of sequential detonations; and the environmental protection factors relevant to nuclear stimulation of natural gas reservoirs. (L.C.L.)

48014 (PNE–WW–8) PROJECT WAGON WHEEL. (El Paso Natural Gas Co., Tex.). 1971. 26p. (CONF-720440–1). Dep. NTIS.

From Annual meeting of the Green River Valley Cattlemen's Association; Pinedale, WY. (29 Apr 1972).

The Wagon Wheel Project for evaluating the use of sequentially fired, vertically spaced, multiple nuclear explosives for stimulating natural gas production is described. Information is included on: the selection of the site of the natural gas reservoir in Sublette County, Wyoming; comparison of nuclear versus conventional stimulation methods; safety requirements and evaluations; development of new explosives; seismic hazards; radiation hazards from atmospheric contamination by flared gas and from contamination of ground waters in the test area; production of natural gas from the Gasbuggy Event; and projected time schedule for completing the Wagon Wheel Project. (L.C.L.)

48015 (PNE–WW–10) PROJECT WAGON WHEEL: NUCLEAR EXPLOSIVE STIMULATION OF A NATURAL GAS WELL. Rogers, Leo A.; Randolph, Philip L. (El Paso Natural Gas Co., Tex.). 15 Mar 1972. 30p. Dep. NTIS.

Project Wagon Wheel is a proposed experiment to stimulate a natural gas well in west central Wyoming with nuclear explosives. It involves sequentially detonating several explosives at different depths in the same well. By this means a large vertical section can be stimulated. This technique is expected to be applicable to low-permeability reservoirs where the gas-producing horizons are distributed over a large vertical distance. Information relating to geology, hydrology, rock properties and reservoir parameters has been obtained from wells drilled in the area. Predictions indicate that by stimulating the well between 9,000 and 11,700 ft about 21 billion standard ft^3 of natural gas might be recovered in twenty years. Predictions on radioactivity indicate that the maximum radioactivity from tritium in the produced gas will be less than 4×10^{-7} Ci per standard ft^3. To test the stimulated well, gas will be produced and flared. During this flaring the radioactivity exposure to the general population will be much, much less than 1% of natural background radiation. The Project will be a major step in determining whether this technique is a practical method for producing gas from deep, massive low-permeability reservoirs that are not commercial by conventional methods. (auth)

48016 (UCID–30049) STEM: A COMPUTER PROGRAM FOR CALCULATION OF STEMMING LOADS. Norris, D. Jr.; Staats, J.; Kleck, W. (California Univ., Livermore. Lawrence Livermore Lab.). Jun 1972. 21p. Dep. NTIS.

Sand used to backfill an underground nuclear test emplacement hole causes a substantial increase in load at the surface beam which supports the downhole pipe string. A programmed model is presented which accounts for variance in pipe diameter and weight, dragplates, backfill loads on projected string areas, and cable trays. Mud or internal bore backfill simulates field conditions. Load release is available at any backfill level and is accomplished by specifying the top displacement of the string. Open frame structures may be loaded with backfill material as the backfill surface rises. Complete options are given in a data preparation section. (auth)

48017 (UCRL–51226) ANALYSIS OF GAS STIMULATION USING NUCLEAR EXPLOSIVES. Rubin, B.; Schwartz, L.; Montan, D. (California Univ., Livermore. Lawrence Livermore Lab.). 15 May 1972. Contract W-7405-eng-48. 72p. Dep. NTIS.

The U. S. presently is faced with a developing crisis in its energy resources and specifically in its supply of natural gas. The use of nuclear explosives in the stimulation of low-permeability gas reservoirs has the potential of supplying more than 300 trillion ft^3 of gas, an amount greater than the nation's presently proven gas reserves. Two nuclear-explosive gas-stimulation experiments have produced a substantial quantity of gas. An economic projection is made of commercial production (after the successful completion of a research and development program) for nuclear-explosive stimulation of wells in the Piceance and Green River Basins in Colorado and Wyoming. The internal rate of return on investment varies from 7½ to 28½% depending on the properties of the reservoirs and the required number of explosives per well, assuming a wellhead price for gas of 40 ¢ per thousand ft^3. A schedule is proposed for the commercial development of the Piceance and Green River Basins that could lead to an annual gas production rate of 3.4 trillion ft^3 by the year 2000. Based on a hypothetical example in which all the gas would be used in California, it is calculated that the average whole-body radiation exposure to individuals in the California population would be between less than 0.45 and 0.64 millirem/y, compared with the 170 millirem/y average allowable exposure to the population recommended by official guidelines. Compared with other alternatives for increasing U. S. gas production, nuclear stimulation appears to have advantages in terms of required capital investment and gas sales price. A research and development program will be required to achieve this projected capability for nuclear-explosive gas stimulation. The cost of this development program to achieve initial commercial production in about five years is estimated to be from $100 to 150 million. It is recommended that a vigorous government-industry program be conducted to develop this technology to help relieve the shortage in natural gas supply. (auth)

48018 (UCRL–51233) EXAMINATION OF RAYLEIGH WAVES PRODUCED BY SHEAR AND COMPRESSIONAL LINE SOURCES. Hannon, W. J. (California Univ., Livermore. Lawrence Livermore Lab.). 2 Jun 1972. Contract W-7405-eng-48. 50p. Dep. NTIS.

The response of a semi-infinite homogeneous medium to shear and compressional line sources is considered. Various energy and energy density functions are obtained from the expressions for the displacements as a function of time and position. Comparison of the results for the two sources indicates that the shear source is a better generator of Rayleigh waves than is the compressional source. Depending on the normalization used, a factor of from 3 to 30 is appropriate for Poisson's ratios typical of rocks. This suggests that the surface wave magnitude versus body wave magnitude discrimination technique used in seismic identification may be affected by the use of shaped cavities or other approaches which enhance the generation of shear waves by explosions. The distribution of energy density as a function of time and position indicates that in a homogeneous half space the immediate sources of energy for the Rayleigh wave are the energy radiated from late time distortional energy concentrations above the source and the energy from regions where the reflected shear waves are large. The energy from these source regions interacts with the free surface to form the Rayleigh wave. (auth)

48019 (USGS–474-141) A SEISMICITY STUDY ALONG THE NORTHERN DEATH VALLEY-FURNACE CREEK FAULT ZONE, CALIFORNIA–NEVADA BOUNDARY. Papanek, P. J.; Hamilton, R. M. (National Center for Earthquake Research, Menlo Park, Calif.). 1972. Contract AT(29-2)-474. 41p. Dep. NTIS.

A radio-telemetry seismograph network of seven stations was operated from March 1970 through January 1971 in the Fish Lake Valley area on the California–Nevada boundary, at the northern end of the Death Valley–Furnace Creek fault zone. Local seismic activity was monitored for six underground nuclear explosions of magnitude 5 or larger at the Nevada Test Site during this period, including the Handley event of magnitude 6.5. No effect of the explosions on the seismicity of the area was detected. Epicenters were determined for 96 earthquakes in the vicinity of the seismic network. Most of the shocks lie in two clusters, one 2 to 3 km from the fault zone and including a trend subparallel with it, and the other 6 to 10 km from the fault zone. Depths computed for shocks inside the network ranged from near surface to 11.3 km. Fault-plane solutions for earthquakes near the fault zone, though inconclusive, point to a predominance of right-lateral strike-slip motion along the direction of the main fault. (auth)

48020 METHOD OF INCREASING SIZE OF UNDERGROUND NUCLEAR CHIMNEY. Silverman, Daniel (to Pan American Petroleum Corp.). U. S. Patent 3,677,342. 18 Jul 1972. Filed 29 Dec 1969.

An underground cavity formed deep in the earth by detonation of a nuclear device is extended vertically by drilling a borehole from the earth's surface to a depth D which is above the expected top of the cavity chimney by a distance equal to or greater than d, where d is the thickness of a slab of rock of the diameter of the chimney that will be self-supporting. A horizontal propped fracture is created at depth D, and liquid explosive is placed in the fracture and detonated. The shock force of the explosion causes the slab of thickness d to be rubbleized and driven down into the chimney. This process can be repeated for successive slabs of thickness d. Alternatively, vertical boreholes can be drilled outside of an adjacent wall of the cavity, vertical fractures created with their planes parallel to the wall of the borehole, the fractures loaded with liquid explosive and detonated, causing a slab of the wall to be driven into the chimney and rubbleized. (Official Gazette)

Protective Structures and Equipment

Refer also to abstracts 47967 and 48074.

Safety Engineering

Refer also to abstract 48483.

48021 (SRD-R–12) SAFETY FACTORS AND PROBABILITY IN STRUCTURAL DESIGN. Burnup, T. E.; Roberts, D. (United Kingdom Atomic Energy Authority, Risley (England). Safety and Reliability Directorate). Jan 1972. 28p. Dep. NTIS (U. S. Sales Only).

The traditional safety factor approach to structural design and newer ideas on failure probability are summarized. The general assumption is made that current design and building practice will associate some estimated failure rate with a safety factor. It is also assumed that if another potential failure rate is needed then a new safety factor must be used. The relationships are derived for normal and lognormal distributions. (auth)

48022 (WCAP–7897) CHARACTERISTICS OF TORNADO GENERATED MISSILES. Paddleford, D. F. (Westinghouse Electric Corp., Pittsburgh, Pa.). Apr 1969. 34p.

Results are presented of an investigation in which the wind field of a tornado has been described using relations appearing in the technical literature and solutions of the trajectory of a spectrum of missiles have been obtained numerically for a number of cases. The resultant size-velocity relationship for missiles generated by a 300-mph tornado is summarized graphically. The results are utilized to obtain the velocities of typical objects that could be postulated as potential tornado missile sources. (J.R.D.)

Vacuum Engineering

Refer also to abstract 47975.

48023 ULTRA-HIGH-VACUUM UNIT. Babenko, F. M.; Yanov, A. E.; Bagrov, N. N.; Kostin, Yu. K. (Physical-Technical Inst. of Low Temperatures, Kharkov). Instrum. Exp. Tech. (USSR) (Engl. Transl.); 14: No. 5, 1446-8(1971).

Translated from Prib. Tekh. Eksp.; 14: No. 5, 157-9(1971).

A vacuum unit having a double-walled chamber and a working volume of 80 liters is described. The achievement of a vacuum of 10^{-11} to 10^{-13} torr is ensured either by a cryogenic helium pump or by a sorption pump with cooling to liquid nitrogen temperatures. (auth)

48024 DESIGN AND PERFORMANCE OF A HIGH-SPEED ECONOMICAL ULTRAHIGH VACUUM CHAMBER UTILIZING TITANIUM SUBLIMATION. Shen, L. Y. L. (Bell Labs., Murray Hill, N. J.). Rev. Sci. Instrum.; 43: No. 9, 1301-6(Sep 1972).

The pumping action produced by evaporating titanium onto very large surfaces held between 78 and 300 K has been studied inside a 60 liter steel tank. The present design offers high pumping speed at pressures below 10^{-9} Torr. The partial pressures of different residual gases under operational conditions were measured with a mass spectrometer. The partial pressures of several gases are reported as a function of temperature. (auth)

ENVIRONMENTAL AND EARTH SCIENCES

Minerals and Ores

Refer also to abstracts 47698, 47769, and 48320.

48025 (BARC–587) BENEFICIATION STUDIES ON A URANIFEROUS PHOSPHATE-ROCK (MUSSOORIE AREA-U. P.). Rambabu, Ch.; Majumdar, K. K. (Bhabha Atomic Research Centre, Bombay (India)). 1972. 18p. Dep. NTIS (U. S. Sales Only).

The phosphate-rock sample from Bardada-Chamsari-Chulidhar locality in Mussourie syncline shows unusually high radioactivity (chemically $U_3O_8 = 0.043\%$, $P_2O_5 = 29.6\%$). Sieve analysis, leaching tests, and autoradiographs proved that most of the uranium is chemically bound up with calcium phosphate mineral (collophane). No discrete uranium mineral is so far detected. Mineralogical composition and complete chemical analysis are given. Pure collophane was separated and its x-ray diffraction spectra measured. Trials were made to oxidize the uranium in phosphate by heat treatment (700 to 900°C) in the presence of alkali salts, so that uranium might be preferentially leached by acids. This did not work; the uranium was found to go into solution only on dissolution of calcium phosphate. Recovery of phosphate by physical beneficiation provides a means also of conserving whatever uranium is locked up with collophane. Straight flotations on minus 48-mesh feeds with oleic acid were tried. With 5 kg-charges, combination methods employing calcination, washing, followed by magnetic separation and flotation on heat treated finer fraction were done. Straight calcination, quenching, and washing was found to be a simple and efficient process. The product of combination method is a high acid-grade concentrate fit for fertilizer purpose, containing not more than 2% Fe_2O_3. (auth)

48026 (RLO–2229-T-1-11) CHEMICAL COMPOSITION OF BOTTOM SEDIMENTS OF THE BEAUFORT SEA, ARCTIC OCEAN. Naidu, A. S.; Hood, D. W. (Alaska Univ., College. Inst. of Marine Science). 1971. Contract AT(04-3)-310. 17p. (CONF-720816–1). Dep. NTIS.

From 24th international geological congress; Montreal, Quebec, Canada (21 Aug 1972).

Several major (Fe, Mn, K, Na, Mg, and Ca) and minor (Rb, Li, Zn, Ni, Co, Cu, and U) elements, organic carbon, and carbonate were analyzed from surface sediments of the Beaufort Sea floor. Compared to the low-latitude deep-sea sediments there was a deficit of all elements except U and lower Mn/Fe, Na/K, and Ca/Mg ratios in the polar sediments presently analyzed. The reason for the relative paucity of these elements in Beaufort Sea sediments is not well understood. This could be due to limited influxes of chemogenous and biogenous components and lower intake of exchangeable ions. Such effects might be related to retarded chemical activity at near freezing temperatures of Arctic waters, and possibly, to lower yearly primary productivity. Chemically, the Arctic sediments analyzed were similar to Antarctic sediments (Angino, 1966). This suggests that glacial-marine sediments have a distinct chemical character and that geochemical criteria have potential use in the recognition of glacial marine paleosediments. Sediments of the shelf (<64 m) were distinguishable from those of the extra-shelf (slope and basin) in being relatively enriched in carbonate and Zn, and having lower Na/K ratio and organic carbon. There was a marked increase in Mn in the abyssal basin sediments. Sediment organic carbon correlated with clay percent, whereas carbonate content correlated with the amounts of coarse calcareous lithogenous and bioclastic components. Elemental geochemistry is discussed, taking into consideration the granulometric and clay mineralogic compositions of the sediments and the interelement associations. (auth)

48027 PRESENT SITUATION OF URANIUM AND THORIUM IN CANADA. Com. Naz. Energ. Nucl., Notiz.; 18: No. 6, 45-9 (Jun 1972). (In Italian).

A review is presented of the present picture and prospects of the uranium and thorium industry in Canada, with numerous diagrams and tabulations. (auth)

48028 AFRICAN URANIUM MINING. A SURVEY COMPARING DEPOSITS, RESERVES, AND PRODUCTION. Dahlkamp, F. J. (Uranerzbergbau GmbH und Co. KG, Bonn). Erzmetall; 24: No. 11, 555-9(1971). (In German).

A comprehensive set of significant data on uranium mining in Africa is given in tables, covering both operating and planned plants as well as abandoned mines. This is followed by an outline of the U_3O_8 output capacity of African plants, including plants already in operation and those planned to become operational in the near future, i.e., after Feb. 1971. (auth)

48029 PHASE STUDIES IN THE SYSTEM $FeZr_xTh_{2-x})O_5$. Braganza, D. A.; Rama Rao, K. (Curr. Sci. (India); 41: No. 15, 564-5(5 Aug 1972).

In order to study the structures of the zirkelite and thorianite minerals, their structural correlation, and the phases developed, the minerals were synthesized and their x-ray patterns studied. With the introduction of Th^{4+} ions in the β-site replacing Zr^{4+} ions in zirkelite lattice, the lattice parameters increased slowly. When 60% of Th^{4+} was introduced into the lattice, the thorianite phase made its appearance with very faint lines and persisted until the last composition was reached. The patterns were indexed on the basis of cubic symmetry with the lattice dimensions a = 6.29 A for zirkelite and a = 6.368 A for thorianite. It was observed that the main lines of zirkelite and thorianite were almost coincident, and thus it is reasonable to assume that these minerals are isostructural having the octahedral units containing Fe^{2+} ions in the center of the octahedron, the oxygen atoms in the middle of the sides and Zr^{4+}, Th^{4+} ions in the corners. The octahedral units are so arranged that the combination of these units leads to a close packed unit cubic cell. (P.C.H.)

48030 ^{18}O, ^{13}C, Sr, AND Mg IN A NUMMULITIC LAEVIGATUS POPULATION. AN ATTEMPT TO INTERPRET THE RESULTS AND THE GEOCHEMICAL CONSEQUENCES. Letolle, Rene (Univ., Paris). Rev. Geogr. Phys. Geol. Dyn.; 13: No. 5, 439-46(Nov 1971). (In French).

The distribution of 4 geochemical parameters in a homogeneous fossil population is discussed. A simple model (together with its extension) based on the principle of chemical kinetics enables the observed distributions to be explained. Diagenetic differences account for these distributions. The Sr distribution is a very good indicator of exchange for isotopic studies. (France)

Radioactive Effluents

Refer also to abstracts 47739, 49889, 49890, 49900, 49919, 49930, and 49935.

48031 (CEA-CONF-2007) CONTINUOUS MEASUREMENT OF α AND β RADIOACTIVITY OF WATER IN VIEW OF MAXIMUM PERMISSIBLE CONCENTRATIONS FOR THE PUBLIC. Matutano, J.; Hory, P.; Grivaud, L. (Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires). [nd]. 11p. (In French). (CONF-720328-1). Dep. NTIS (U. S. Sales Only).

From Sixth international congress on new trends in radiation protection; Bordeaux, France (27 Mar 1972).

Some of the liquid effluents from the CEN–Saclay were put into the Saclay lakes which contain large quantities of fish. The radioactivity level was measured to be less than or equal to the MPC of drinking water. A detector consisting of two flow counter which operates as a proportional counter was developed for the continuous measurement of the activity (10^{-5} to 10^{-8} Ci/m^3) of liquid effluents. The equipment used in the measurements concentrates the radioactivity of a volume of water by evaporation. The evaporation is effected by the atomization of the water in a hot air flow; the dry aerosol is recovered using air filtration. The efficiency and performance of the apparatus are given. (France)

Radioactivity Transport and Monitoring

Refer also to abstracts 47864, 48012, and 48357.

48032 (LA–4970) ENVIRONMENTAL MONITORING IN THE VICINITY OF THE LOS ALAMOS SCIENTIFIC LABORATORY, JULY–DECEMBER 1971. Herceg, Joseph E. (comp.) (Los Alamos Scientific Lab., N. Mex.). Jul 1972. Contract W-7405-eng-36. 48p. Dep. NTIS.

The environmental monitoring program in effect at the Los Alamos Scientific Laboratory of the University of California for the last half of calendar year 1971 is described. Results of programs designed to monitor radiation levels in the Laboratory environs, including the atmosphere, local surface and ground waters, sediments, and soils are presented. These measurements were used to make estimates of the dose commitments due to plutonium and tritium concentrations in air. (auth)

48033 ENVIRONMENTAL POLLUTION WITH RADIOACTIVITY AND PUBLIC HEALTH RESPONSIBILITIES. Yamagata, Noboru (Inst. of Public Health, Tokyo). Koshu Eiseiin Kenkyu Hokoku; 20: No. 1, 79-93(Mar 1971). (In Japanese).

The history of environmental surveillance for radioactive fallout in Japan since the incidence of nuclear bomb test in Bikini atoll in March 1954 is reviewed and the present radiation pattern composed of natural, medical and fallout exposures is summarized. The existing legal system for radiation control, research and development is criticized in view of the public health responsibilities in radiation protection. Recommendations are given on the basis of the principle: it is insane that the Atomic Energy Bureau (AEB), Science and Technology Agency (STA), the principal duty of which is the development of atomic energy takes leadership in radiation protection of the public. It is concluded that: a part of the competence of the Atomic Energy Commission and AEB should be transferred to the Ministry of Health and Welfare (MHW) and the Radiation Council which presently acts as an advisory committee for the STA should be attached to the MHW; the MHW should provide a single focal point for evaluation of the total health impact of all sources of radiation and a new research institute such as Institute of Radiological Health should also be created in order to technically assist in this evaluation; and the existing surveillance system for environmental radioactivity operated by AEB and solely aimed at the global fallout from nuclear explosions should be reconsidered and reduced in scale on the one hand and a new system aimed at the atomic energy industries should be created by the MHW on the other. (Japan)

Atmosphere

48034 (CLOR–88/D) CONTINUOUS MEASUREMENTS OF ^{222}Rn CONCENTRATION IN AIR. Biernacka, M.; Jagielak, J.; Zak, A. (Centralne Laboratorium Ochrony Radiologicznej, Warsaw (Poland)). 1972. 11p. (In Polish). Dep. NTIS (U. S. Sales Only).

A method for the continuous measurement method of ^{222}Rn concentrations in air and construction of the device are described. Detection limit of this method is 3000 pCi/m^3. The device is intended for measurements of ^{222}Rn concentration in uranium mines, in industrial establishments for processing uranium ore, and for routine control of work with open sources of ^{226}Ra. (auth)

48035 (UCRL–73822) GEOGRAPHICAL VARIATIONS IN ENVIRONMENTAL RADIATION BACKGROUND IN THE UNITED STATES. Lindeken, C. L.; Peterson, K. R.; Jones, D. E.; McMillen, R. E. (California Univ., Livermore. Lawrence Livermore Lab.). 24 Mar 1972. 30p. (CONF-720805–1). Dep. NTIS.

From second conference on natural radiation environments; Houston, TX. (7 Aug 1972).

During the period from March 1 to June 1, 1971, the Lawrence Livermore Laboratory made simultaneous measurements of environmental radiation background at 107 weather stations throughout the United States. Measurements were made using $CaF_2:Dy$ thermoluminescent dosimeters (TLD-200). Freshly annealed dosimeters were mailed to the stations where they were exposed in the station's instrument shelter. At the end of the exposure period, the dosimeters were returned to Livermore for readout. Light output is proportional to the radiation dose received by the phosphor from the sum of terrestrial and cosmic sources. The cosmic component was estimated from the elevation and geomagnetic latitude of the station, and terrestrial radiation was obtained by difference. Median environment radiation exposure rate (terrestrial + cosmic) was 9.4 μR/hr with a range from 3.7 to 19.9 μR/hr. The median terrestrial exposure rate was 5.5 μR/hr. Low backgrounds were found in the Hawaiian Islands, Northern Alaska, and Florida. High backgrounds in the Rocky Mountain States are due more to higher terrestrial radiation than to increased cosmic radiation. The thermoluminescent dosimetry procedure employed in this pilot study appears to be suitable for large-scale synoptic monitoring at costs which are modest compared with using portable instruments. (auth)

48036 EXPERIENCES OF RADIATION MONITORING IN THE FUEL REPROCESSING TEST PLANT. Ohnishi, Takeshi; Minami, Kentaro; Sato, Nobuyuki; Niino, Futao; Ohuchi, Masafusa (Japan Atomic Energy Research Inst., Tokai). Hoken Butsuri; 6: No. 3, 137-41(Sep 1971). (In Japanese).

The Fuel Reprocessing Test Plant at JAERI was operated during the period of 1968 and 1969 to gain experiences of the fuel reprocessing. Fuel elements reprocessed were irradiated in the JRR-3 reactor up to about 700 MWd/ton and cooled for 87 to 300 days. The experiences of radiation monitoring including contaminations and radiation levels encountered during the fuel reprocessing, and the results of inplace test of air cleaning filters installed in the plant are described. (auth) (Japan)

48037 MONITORING OF AIRBORNE RADIOIODINE RELEASED FROM THE FUEL REPROCESSING TEST PLANT OF JAERI. Minami, Kentaro; Ohnishi, Takeshi; Sato, Nobuyuki; Niino, Futao; Ohuchi, Masafusa (Japan Atomic Energy Research Inst., Tokai). Hoken Butsuri; 6: No. 3, 143-8(Sep 1971). (In Japanese).

The Fuel Reprocessing Test Plant at JAERI was operated during the period 1968 and 1969 to gain experiences of the fuel reprocessing. The fuel elements reprocessed were irradiated in the JRR-3 reactor up to about 700 MWd/ton and cooled for from 87 to 300 days. The measured results of airborne radioiodine released in each stage of chemical processing are described and the collection efficiency of the charcoal-impregnated filter paper for radioiodine in the presence of process off-gases such as NO, NO_2, NH_3, HNO_3 and solvents encountered during the fuel reprocessing is discussed. (Japan)

Soil

Refer also to abstracts 48288 and 48297.

48038 (RLO–2227-T-12-32) PHOTOCHEMICAL DEGRADATION OF SEDIMENT ORGANIC MATTER: EFFECT ON ^{65}Zn RELEASE. Lenaers, William Michael (Oregon State Univ., Corvallis). 30 Aug 1971. 64p. Dep. NTIS.

Thesis.

Columbia River sediment was irradiated with ultraviolet light to determine if organic material could be removed without altering the sorptive properties of the hydrous oxides of iron and manganese. A laboratory preparation of ^{65}Zn-spiked hydrous ferric oxide was subjected to ultraviolet irradiation in order to assess the photochemical effect upon ^{65}Zn release. The photochemically induced release of ^{54}Mn present on the Columbia River sediment was used to assess the effect on the hydrous oxides of manganese. The ultraviolet irradiation proved effective in removing up to 68% of the sedimentary organic material in 17 hours without causing release of ^{65}Zn, ^{46}Sc, or ^{60}Co. While the ultraviolet irradiation had no effect upon ^{65}Zn release from laboratory preparations of hydrous ferric oxides and ^{65}Zn spiked montmorillonite, a significant release of ^{54}Mn resulted from the photolysis treatment. The removal of ^{54}Mn was not accompanied by the release of sorbed ^{65}Zn or ^{46}Sc (nuclides expected to be sorbed by hydrous oxides), nor did there appear to be any permanent change in the nature of the ^{54}Mn on the sediment. Although it is possible that the hydrous oxides of manganese are affected by the ultraviolet treatment, it is likely that another species, such as the carbonate, is the species involved. Photo-oxidation appears to provide a method of obtaining sediments with substantially reduced organic content without affecting the sorptive properties of hydrous oxides or clay minerals. This result should allow the use of uptake studies to determine the importance of organic material in trace metal sorption by sediments. (auth)

48039 RETENTION OF RADIOACTIVE SUBSTANCES IN SOILS: PROPERTIES OF CZECHOSLOVAK SOILS. Benes, Jaroslav (Radiological Dosimetry Lab., Prague); Dlouhy, Zdenek. Jad. Energ.; 18: No. 7, 229-32(Jul 1972). (In Czech).

Samples of most important pedologic types of soils occurring in the Czechoslovak territory were studied from the viewpoint of their sorptive properties for two critical radionuclides. Sorptive velocities of ^{90}Sr and ^{137}Cs were determined; changes in distribution coefficients for both radionuclides were expressed as a function of the volume of liquid phase, and as a function of the amount of soil coming into contact with contaminating solution. (auth)

48040 TOTAL β-RADIOACTIVITY AND ^{40}K CONTENT IN BROWN FOREST SOILS OF THE CENTRAL BALKANS AND THE NORTHWESTERN RHODOPES. Raikov, Lulcho; Naumov, Zdravets; Milchev, Mikhail; Dimitrova, Emiliya (Inst. of Soil Science, Sofia). Gorskostop. Nauka; 7: No. 2, 27-35(1970). (In Bulgarian).

Studies on the total β-radioactivity and ^{40}K content in brown forest soils in the central Balkan Mountains showed that of the total β-radioactivity the greater part came from ^{40}K. The total β-radioactivity of these soils ranged from 8 to 21 pCi/g soil, in the soils of northwestern Rhodopes from 2 to 29 pCi/g. The higher total β-radioactivity in most of the soil types studied in the northwestern Rhodopes was related to the higher content of K in the granite-gneiss parent rock and to the higher altitude above sealevel. (Euratom)

48041 BACKGROUND ACTIVITY OF TAIWAN. Weng, Pao-shan (Tsing Hua Univ., Hsinchu, Taiwan); Tsai, Chao-ming; Su, Shian-jang; Huang, Chen-hung; Chu, Tieh-chi. Hoken Butsuri; 6: No. 3, 131-6(Sep 1971).

The gamma-ray spectroscopy method was used to determine the natural activity of soil samples taken from twenty-six locations including three nuclear reactor sites in order to obtain the average background activity of Taiwan. Direct measurement of natural activity was also carried out by means of ionization chambers coupled with a vibrating reed electrometer. Fallout activity was detected during this investigation by the spectroscopy method, and the chemical method was used to analyze its main components ^{90}Sr and ^{137}Cs nuclides. The background radiation thus measured varied from 5.2 μR/h to 15.2 μR/h with an average value of 11.8 μR/h while the gross activity concentration in air varied from 1.94×10^{-13} μCi/cm^3 to 4.95×10^{-13} μCi/cm^3 with an average value of 3.58×10^{-13} μCi/cm^3. (auth)

Water

48042 (IAEA–136, pp 3-10) DEVELOPMENT OF REFERENCE METHODS AND PREPARATION OF REFERENCE SAMPLES. (International Atomic Energy Agency, Vienna (Austria)). 1971. INIS.

For purposes of intercalibration, the Laboratory distributed to 55 institutes from 26 countries, samples of seawater contaminated with various radionuclides. Separate analyses were carried out on the samples to obtain precise information on the homogeneity of the samples. Because of the tendency of some radionuclides to be sorbed onto the wall of the containers, studies were carried out with naturally-occurring iron in seawater stored in polyethylene bottles using ^{59}Fe as a tracer. Results showed that even in acidified seawater some fractions of iron attach to the container wall. For the evaluation of different analytical procedures, a thorough re-evaluation of the solvent extraction of zinc with dithizone was carried out. Work was done for the preparation of reference samples for radioactivity measurements in sediments and the reference methods to be used for the determination of radionuclide sorption by marine sediments. (INIS)

48043 (LIB/Trans–420) ESTIMATED CONTAMINATION OF OPEN DRINKING WATER RESERVOIRS FROM FISSION PRODUCT FALLOUT AFTER NUCLEAR EXPLOSIONS AND EXTREME REACTOR ACCIDENTS. Jacobi, W.; Stolterfoht, N.; Haberer, K. (Hahn-Meitner-Institut fuer Kernforschung, Berlin (West Germany)). Translated by I. A. Mumme (Australian Atomic Energy Commission Research Establishment), from report HMI-B–88. 36p. Dep. NTIS (U. S. Sales Only).

An abstract of this article prepared from the original appeared as NSA 25: 46805 (1971). (Australia)

48044 (NP–19391) TRITIUM CONCENTRATION OF A VARIETY OF WATER SAMPLES. FIFTH LISTING. Hughes, M. W.; Dighton, J. C. (Commonwealth Scientific and Industrial Research Organization, Adelaide (Australia). Div. of Soils). 1971. 6p. Dep. NTIS (U. S. Sales Only).

Samples collected between 1/5/70 and 28/5/71 and analysed between 22/2/71 and 25/8/71 totalled 133. Measurements were taken in South Australia and included rainfall, surface and underground water samples, and values for water obtained by burning wheat and wine samples in oxygen. (Australia)

48045 (STU–69-1058/U-783) ON THE EXCHANGE OF TRITIUM IN THE GULF OF BOTHNIA. Soederlund, Rolf (Stockholm Univ. (Sweden). Inst. of Meteorology. International Meteorological Inst., Stockholm (Sweden)). Sep 1971. 28p. Dep. NTIS (U. S. Sales Only).

The relative importance of the molecular addition of tritium into the Northern Baltic Basin was investigated by means of a simple two-box model. The amount of tritium added into the sea is annually a factor one to three times the amount added by precipitation. The study was made to gain knowledge regarding the process of tritium transfer from the water vapor into the surface water of the Gulf. (Sweden)

48046 (UCRL–73745) RADIONUCLIDE TRANSPORT STUDIES IN THE HUMBOLDT BAY MARINE ENVIRONMENT. Heft, R. E.; Phillips, W. A.; Ralston, H. R.; Steele, W. A. (California Univ., Livermore. Lawrence Livermore Lab.). 30 Jun 1972. 24p. (CONF-720708–9). Dep. NTIS.

From Symposium on the interaction of radioactive contaminants with the constituents of the marine environment; Seattle, WA. (10 Jul 1972).

Operation of the Pacific Gas and Electric Company nuclear power reactor (65 MW(e) boiling water) at Humboldt Bay, Eureka, California, produces as a by-product in low concentration in aqueous solution a number of radionuclides (fission products, ^{65}Zn, ^{60}Co, ^{54}Mn, ^{3}H, etc.). At irregular intervals the accumulated radioactive liquid waste is released into the Bay in accordance with limits prescribed by the Atomic Energy Commission and the State of California North Coastal Regional Water Control Board. The Lawrence Livermore Laboratory, in cooperation with the Pacific Gas and Electric Company has undertaken a program to study the transport of the released radionuclides through the Humboldt Bay marine environment. The Bay is considered to be divided into five aqueous pools. Within each pool, the radionuclides are partitioned among some or all of the following compartments—aqueous solution, bottom sediment, suspended sediment, benthic algae, eelgrass, phytoplankton. The experimental program consists of three main parts—assay of each release for gamma-emitting radionuclides; monthly analyses for radionuclide and stable element concentration in each of the listed compartments; and intercompartment exchange rate studies. Radionuclide release data accumulated since April 1971 is compared with monthly measurements of radionuclide concentration in the bay. It was found that the amounts released have little effect on field concentrations. Exchange study programs now being carried out in the discharge canal and the laboratory are discussed. The nature and status of a proposed transport model for the bay is described. (auth)

48047 RADIOACTIVE SPRINGS IN THE KINKI DISTRICT AND THEIR RADON SOURCES. Katsura, Kyozo (Kyoto Univ.). Onsen Kagaku; 21: No. 3-4, 121-33(Dec 1970). (In Japanese).

About seventy radioactive springs exist in the Kinki District. They are summarized chiefly from the geological point of view and the origin of radon contained in the springs is discussed. Quite remarkable are the tendencies that radioactive springs are apt to be associated with granite, zones of fault and contact metamorphism as well. The radium content of rock samples taken from the vicinity of the springs or the drilled well at the spring area was normal, but the weathered rock was richer in radium than the fresh rock of the same type. It was also found that fault clay or fault breccia was impregnated with radium in most cases. Some experiments on the contribution of radium in rock to the radon content in water were carried out. Crushed granite of from 0.5 to 1.0 kg enclosed in a bottle with water more than three weeks released 3 to 6×10^{-11} Ci of radon per litre, a quantity approximating one-tenth of the equilibrium one with radium in the sample taken. This implies that the part affecting the release of radon is limited to a thin surface layer due to the low diffusion coefficient of radon in rock. A fictitious average thickness responsible for the radon release was calculated to be 0.27 mm for the fresh sample and 0.31 mm for the weathered one of Kitashirakawa granite. Finally, a formula is deduced giving the velocity of spring flow which makes the radon content maximum during the passage through sand containing radium under some conditions. (auth) (Japan)

Ecosystems and Food Cycles

Refer also to abstracts 48194, 48234, 48289, and 48298–48301.

48048 (COO–2122-9) SYNTHESIS AND ANALYSIS OF ALASKAN RADIATION ECOLOGY DATA. Second Annual Progress Report, September 1, 1971–May 31, 1972. Hanson, W. C.; Whicker, F. W. (Colorado State Univ., Fort Collins. Dept. of Radiology and Radiation Biology). 31 May 1972. Contract AT(11-1)-2122. 15p. Dep. NTIS.

The purpose of this research was to organize, analyze, and summarize 12 y of radiation ecology research performed in northern Alaska and present it in lucid discussion relating it to similar studies in other arctic and subarctic regions. The principal focus of the studies was the lichen-caribou-Eskimo food chain that is responsible for concentrating several radionuclides to amounts hundreds of times those measured in Temperate Zone ecosystems. The project activities during the period September 1971 through May 1972 are summarized. During that period, emphasis was placed on completing the extraction of cultural information concerning native populations, summarizing and organizing 1959 to 1970 radionuclide data received from Battelle Memorial Institute Pacific Northwest Laboratory in December 1971, separating and analyzing lichen samples collected in northern Alaska, and preparing the initial synthesis of cultural data that relates to radionuclide burdens in Anaktuvuk Pass residents. Stable element analyses of about 800 biotic samples collected during the period 1963 to 1967 were summarized, with special emphasis upon relating potassium concentrations in lichens to fallout ^{137}Cs concentrations in both lichens and caribou on winter range near Anaktuvuk Pass. These data were then combined with a cesium kinetics model to calculate the first reported estimates of lichen forage consumption rates for free-roaming caribou under natural conditions. These results have important implications for caribou/reindeer management in circumpolar regions because winter range lichen pastures are the limiting factor for deer populations. (auth)

48049 (COO-3011-1) RADIOACTIVE FOODCHAINS IN THE SUBARCTIC ENVIRONMENT. Technical Progress Report, August 15, 1971–August 14, 1972. Miettinen, Jorma K. (Helsinki Univ. (Finland). Dept. of Radiochemistry). May 1972. Contract AT(11-1)-3011. 107p. Dep. NTIS.

Seven articles are included; a separate abstract was prepared for each. (P.C.H.)

For abstracts of individual papers see: 48050–48056.

48050 (COO-3011-1, Paper 43) ACCUMULATION OF ^{137}Cs IN FINNISH LAPPS. Rahola, T.; Miettinen, J. K. May 1972. 12p.

In Radioactive foodchains in the subarctic environment.

Every spring since 1962, the ^{137}Cs content of a group of 80 to 100 Finnish Lapps has been determined using a truck-installed whole-body counter. In order to determine seasonal variations, whole-body measurements were also performed in the autumns of 1962 and 1969. From 1965 until 1969, there was a rapid decrease in the ^{137}Cs body burden. Since 1969, no observable decrease has taken place. The ^{137}Cs body burden causes an annual radiation dose to the standard man of about 8 mrad/nCi/kg body weight. The radiation dose to the most exposed group of reindeer-herders was about 60 mrad in 1970. In Lapland, as well as in other arctic and subarctic regions, an exceptionally efficient enrichment of radionuclides occurs in plants and animals (especially reindeer and caribou), and in people eating the meat of these animals. This enrichment is not typically due to a high regional fallout or to a high local precipitation, but to particular arctic food chains, the best known of which is the chain lichen–reindeer–man. (P.C.H.)

48051 (COO-3011-1, Paper 44) BODY BURDEN OF ^{137}Cs IN FINNISH LAPPS IN MARCH 1972. Rahola, Tua; Miettinen, J. K. May 1972. 6p.

In Radioactive foodchains in the subarctic environment.

The 11th spring measurement of Finnish Lapps was performed in March 1972. Altogether, 62 people were measured, 58 being the same as in 1971. A 12% decrease was observed in the body burden of all persons measured and a 9% decrease in reindeer herders, compared with the levels one year ago. In the reindeer herders (10 men), the decrease of body ^{137}Cs (9%) was slightly less than the average in all Lapps. Factors affecting the ^{137}Cs body burden are discussed. (P.C.H.)

48052 (COO-3011-1, Paper 45) RADIONUCLIDES IN PLANTS (1971) AND REINDEER MUSCLE (1972) FROM FINNISH LAPLAND. Preliminary Report. Rahola, Tua; Miettinen, J. K. May 1972. 6p.

In Radioactive foodchains in the subarctic environment.

Lichen, vascular plants, and reindeer muscle were analyzed in order to understand the trends of the radioactive body burden of the Lapp population. The ^{137}Cs content in lichen was approximately the same as in 1970. In most samples, small amounts of short-lived γ nuclides (^{54}Mn, ^{95}Zr, ^{106}Ru, and ^{125}Sb) were also found. Preliminary results of analyses of reindeer muscle samples, collected at the end of March 1972, disclosed a considerably lower average value of ^{137}Cs (29 nCi/kg fresh weight) than in the spring of 1971 (47 nCi/kg fresh weight). Reasons for the large difference between the two years are discussed. (P.C.H.)

48053 (COO-3011-1, Paper 46) DECREASE RATE OF ^{55}Fe IN THE FOOD CHAIN LICHEN–REINDEER–MAN IN FINNISH LAPLAND. Jaakkola, Timo. May 1972. 18p.

In Radioactive foodchains in the subarctic environment.

The effective half-time of ^{55}Fe was determined in the various components of the lichen–reindeer–man food chain, and the turnover rate of ^{55}Fe was calculated separately for men and women. During spring 1971, 112 blood samples were collected from the same Lapps who were studied in 1966. Simultaneously, an individual food consumption study was performed on these persons in order to facilitate calculation of their dietary intake of ^{55}Fe. Also, lichen and reindeer tissue samples were collected during the period 1969 to 1971 in order to complete the determination of the decreased rate of ^{55}Fe in the first and second links of the lichen–reindeer–man food chain. The effective residence half-time of ^{55}Fe in lichen during the period 1966 to 1970 was found to be 1.3 y, corresponding to a biological half-time of 2.5 y. The effective residence half-time of ^{55}Fe in reindeer muscle was 1.5 y during 1967 to 1971. In 1966 the specific activity of ^{55}Fe (pCi/mg Fe) in women was approximately twice than in men. This difference had disappeared in 1971. (P.C.H.)

48054 (COO-3011-1, Paper 47) BIOLOGICAL HALF-TIMES OF ^{210}Po AND ^{210}Pb IN SOME MARINE ORGANISMS. Kauranen, Pentti; Jaervenpaeae, Teuvo. May 1972. 11p.

In Radioactive foodchains in the subarctic environment.

The biological half-times of ^{210}Po and ^{210}Pb were determined in some marine organisms by labeling them with ^{210}Po or ^{210}Pb and keeping them in an aquarium. In Mesidotae entomon and Mytilus edulis (soft parts), the biological half-time of lead (slow component) was found to be about three times longer than that of polonium. A fast component (half-time a few days) was also observed in most cases in Gammarus zaddachi, in which the fast component was dominant. In Harmothoe sarti the fast component was very small. In general, the biological half-time of polonium seemed to be longer in marine than in terrestrial organisms, which partly explains the high ^{210}Po concentrations found in marine organisms. (auth)

48055 (COO-3011-1, Paper 48) SPECIFIC ACTIVITY OF ^{210}Pb IN THE ENVIRONMENT. Kauranen, Pentti; Miettinen, Jorma K. May 1972. 11p.

In Radioactive foodchains in the subarctic environment.

In connection with studies of ^{210}Pb in arctic food chains, the possibility of using the specific activity of ^{210}Pb (pCi/mg Pb) as an indicator of its origin became of interest. Studies on ^{210}Pb in aerosol samples showed that the specific activity was highest in nonindustrialized Lapland (100 to 2450 pCi/mg Pb) and lowest in Helsinki (18 to 250 pCi/mg Pb). These values depended very much upon the weather and, therefore, the range was wide at each sampling location. Lichen, which grows very slowly, gave an integrated value representing accumulation over many years. The average value for Lapland (900 pCi/mg Pb) was approximately 3 times higher than that for Southern Finland (320 pCi/mg Pb). In reindeer blood, the specific activity was almost the same as in lichen (900 to 1010 pCi/mg Pb). In the blood of Lapps, the specific activity of ^{210}Pb was about 50, while in that of Southern Finns, the value was approximately 20. The higher value observed in Lapps was primarily due to the consumption of reindeer liver and muscle. Determination of ^{210}Pb specific activity in human tissue and in the local air, water, and food will facilitate proper evaluation of the different ^{210}Pb and stable lead intake routes. (auth)

48056 (COO-3011-1, Paper 49) USES, EMISSIONS, AND ANALYSIS OF LEAD, AND ITS LEVEL IN FOODSTUFFS AND DIET. Miettinen, Jorma K. May 1972. 23p.

In Radioactive foodchains in the subarctic environment.

A review is given on the Pb and ^{210}Pb content in foodstuffs and diet, and the situation regarding the relative roles of the three routes of lead intake by man (food, water, and air) preliminary to measurements on specific activity of ^{210}Pb. (72 references). (P.C.H.)

48057 (TID-26126) SYSTEMS ECOLOGY, A TROPICAL RAINFOREST, AND OTHER SYSTEMS. PART 1. COMPLETION OF THE PROJECT BOOK, "A TROPICAL RAINFOREST." PART 2. DEVELOPMENT OF THE CONCEPTS OF ENERGY CIRCUIT MODELS FOR CONSIDERATION OF ENERGETICS AND ENVIRONMENTAL PROBLEMS. Final Reports. Odum, Howard T. (North Carolina Univ., Chapel Hill. Dept. of Zoology. Florida Univ., Gainesville. Dept. of Environmental Engineering). 15 Apr 1972. Contract AT(40-1)-3666. 887p. Dep. NTIS.

Information concerning completion of the book is summarized by including its title page, preface, description page and table of contents. The work on energy circuit models and their simulation is given in the form of manuscripts published or pending and in the form of sections from theses and accounts of student exploratory efforts. (J.R.D.)

48058 (TID-26130) PLUTONIUM AND ITS EFFECTS IN THE ENVIRONMENT. A Selected Literature Survey. Rudolph, A. W.; Carroll, T. E.; Davidson, R. S. (comps.) (Battelle Columbus Labs., Ohio). 30 Jun 1971. Contract W-7405-eng-92. 203p. Dep. NTIS.

Approximately 325 references on effects of Pu on the environment with emphasis on man are given to journals, reports, and conferences for the period 1948 through 1971. Separate author, subject, and report number indexes are included. (P.C.H.)

48059 DEGREE OF CONTAMINATION OF PASTURE FODDER BY ^{90}Sr IN 1965–1967. Firsakova, S. A.; Shirshov, V. A. (All-Union Scientific Research Inst. of Fodders, Lugovaya, USSR). Agrokhimiya; No. 11, 128-231(Nov 1971). (In Russian).

One of the tasks facing researchers since the appearance of radioactive residuals in the biosphere is to lower the transfer of radionuclides, including ^{90}Sr, through the soil-fodder-animal-milk-man chain into the human system. Tests were made on ^{90}Sr contamination of pasture land as affected by the addition of calcium in varying amounts, and by depth of samples taken. The years 1965 to 1967 were considered. The effects of seven different fertilizers were studied; also, the effects of ^{90}Sr contamination on grass yield. (JPRS)

48060 IMPROVED RELATIONSHIP BETWEEN THE DEPOSITION OF ^{90}Sr AND THE CONTAMINATION OF MILK IN THE UNITED KINGDOM. Bartlett, B. O.; Scott-Russell, R.; Jenkins, W. (Agricultural Research Council Letcombe Lab., Wantage, Eng.). Nature (London); 238: No. 5358, 46-8(7 Jul 1972).

It is stated that one of the main difficulties in estimating the integrated radiation dose that the population may receive from environmental ^{90}Sr contamination has been to determine the average extent to which it enters food chains many years after deposition. Environmental surveys gave little information on this in the earlier years of nuclear weapons tests as ^{90}Sr directly retained on vegetation was then the main source of dietary contamination. A better estimate was possible after 1966, however, when the reduced rate of fallout caused uptake from the soil to make the dominant contribution. The integrated total of ^{90}Sr which will enter diet from a given deposition now appears to be about half that suspected a decade ago. In this connection an equation developed in 1958 by the United Nations Scientific Committee on the Effects of Atomic Radiation (UNSCEAR) to relate the annual mean contamination of milk to measurements of fallout is discussed. The processes involved were known to be more complex than the equation implied, but a more adequate analysis was impossible until survey results were available for an extended period. Improvements to this equation base on survey data of later years are considered. (UK)

48061 ACCUMULATION OF RADIOISOTOPES BY GROWING ROE OF TINCA TINCA AND PERCA FLUVIATILIS. Kulikov, N. V.; Bezel, V. S.; Ozhegov, L. N. Ekologiya; No. 5, 73-7 (1970). (In Russian).

The accumulation of ^{144}Ce, ^{106}Ru, ^{95}Zr, and ^{137}Cs by roe of T. tinca (tench) was greater than that of P. fluviatilis (perch). Lowering of the water temperature decreased the accumulation of all the radioisotopes studied. (Euratom)

48062 ESTIMATION OF PRESENT AND FUTURE LEVELS OF EXCESS ^{14}C IN THE ENVIRONMENT FROM THE NUCLEAR TESTS. 1. SIX RESERVOIRS MODEL. Iwakura, Tetsuo (National Inst. of Radiological Sciences, Chiba, Japan). Hoken Butsuri; 7: No. 1, 7-14(Mar 1972).

The mathematical model with multi-compartments (reservoirs) and the computer program for the estimation of rates of change of the excess ^{14}C levels in environments caused by the successive nuclear tests to date are developed. A set of linear differential equations of the first order obtained from nonequilibrium conditions of ^{14}C is solved by Laplace transform. The procedure of the numerical calculations by the digital computer is presented. Input data for the computer are the amount of ^{14}C atoms in steady state in each reservoir, the exchange rate constants of ^{14}C between reservoirs, and the explosion yields in megaton and dates of the nuclear tests. The calculated results are compared with the observed data. The reason of disagreements between calculated and observed concentrations of ^{14}C in several reservoirs is discussed. The possible effect of a significant degree of direct exchange of ^{14}C between the troposphere and the deep sea reservoir in cyclic model is also examined by the computer-aided calculation. As a result of the comparison of the chain model with the cyclic one, it is found that by a slight modification of the chain model to the cyclic one, the calculated concentration of ^{14}C fits fairly well to the observed values. (Japan)

Radiometric Techniques

Refer also to abstracts 48180 and 48221.

48063 (CSIRO-Trans-10562) MEASUREMENT OF ROCK DENSITY AND PROSPECTING FOR HEAVY METAL ORE DEPOSITS USING GAMMA-GAMMA LOGGING. Nakai, J. Translated by M. A. Hintze (Commonwealth Scientific and Industrial Research Organization), from Butsuri Tanko; 22: No. 4, 190-203 (1969). 31p. Dep. NTIS (U. S. Sales Only).

An abstract of this article prepared from the original appeared as NSA 24: 48175(1970). (Australia)

48064 (EGG-1183-1533) WATER EQUIVALENT OF SNOW MEASUREMENTS USING NATURAL TERRAIN RADIATION. Technical Report No. L-1047. Fritzsche, A. E.; Burson, Z. G.; Burge, D. L. (EG and G, Inc., Las Vegas, Nev.). 22 Oct 1971. Contract AT(29-1)-1183. 65p. Dep. NTIS.

Aerial survey data were obtained from repeated surveys of two snow courses during fiscal years 1970 and 1971. Both gross count and spectral peak counting techniques from NaI crystals were used. Analysis indicates that water equivalent can be predicted to an accuracy of ±0.9 cm or 6%, whichever is greater. These uncertainties can be further reduced by better delineation of the airborne radioactivity. (auth)

48065 NEW METHOD OF EXPLORING GROUND WATER BY MEASURING NATURAL RADIOACTIVITY. Ochiai, T. (Agricultural Engineering Research Station, Hiratsuka, Japan). Chikasui To Ido To Ponpu; 14: No. 1, 2-12(Jan 1971). (In Japanese).

A currently used method of finding fissure zones by measuring natural radioactivity is applied to the detection of fissure groundwater. Most regions of volcanic clastic materials or of impervious solid rocks have hitherto been excluded as possible areas for obtaining drinking water by artesian wells. However, some fissure water frequently exists in these grounds in quantities sufficient for drinking water sources, where the impervious materials or rocks have many fissures and form channels for circulating groundwater of meteoric origin. Such fissure zones may well be located, except where surface soil is very thick, by detecting some higher radioactivity shown by them than that of surrounding intact ground. Such radioactivity measurement can be done by car-born sets of instruments which automatically record the net amount of the natural radioactivity coming from the fissured ground, eliminating the effect of cosmic rays. This method has been demonstrated as successful for finding drinking water in a number of "waterless" regions. It may be noted, however, that some fissure zones detected by this radioactivity measurement may not offer the groundwater due to unfavorable conditions. This method has also been used for detecting faults or finding mineral springs. (Japan)

Site Surveys

Refer also to abstract 47997.

48066 (DUN-7841) DIFFUSION CLIMATOLOGY STUDY OF THE 100-N AREA, HANFORD, WASHINGTON. Baker, David A. (Douglas United Nuclear, Inc., Richland, Wash.). 19 Jan 1972. 86p. Dep. NTIS.

A meteorological data acquisition system was procured and set up at the 100-N site at Hanford, Wash. in order to more clearly define the climatological parameters pertinent to the evaluation of the consequences of an accidental release of radioisotopes to the atmosphere from the N Reactor. The measuring equipment consisted of wind and temperature sensors located on a tower at 0, 50, 100, and 200 ft levels above the ground. Data was recorded continuously at 20 sec intervals during 24-h time periods. The operation of the sensors and data recording system is described. Charts and tables are presented which summarize the data acquired from Jan. 28, 1970 to Jan. 28, 1971. (L.C.L.)

48067 (EUR-4841) JNRC ISPRA SITE CHARACTERISTICS. de Bortoli, M.; Gaglione, P.; Gandino, C. (European Atomic Energy Community, Ispra (Italy). Joint Nuclear Research Center). May 1972. 98p. (In Italian).

The main features of the Ispra site including the meteorological, geological, hydrological, demographical, and ecological aspects are described. The information was gathered partly from reports available at the Ispra Euratom JRC, partly from the Ufficio Provinciale di Statistica di Varese, and partly from inquiries performed directly by the Site Survey Meteorology Section of the Division Protection. (auth)

48068 (NP-19375) RELATIONSHIPS OF EARTHQUAKES AND GEOLOGY IN WEST TENNESSEE AND ADJACENT AREAS. (Tennessee Valley Authority, Knoxville). 28 Jun 1972. 380p.

An investigation was conducted to evaluate the seismic potential of the northern portion of the Mississippi Embayment province based on the interrelationships between seismic history, geologic history, and geologic structure of the region. The area of prime interest is approximately bounded by the 35th and 37th parallels of latitude and the 88th and 91st meridians of longitude. Data were compiled on all earthquakes known to have affected the region. Data for each event included time, epicentral location, intensity and/or magnitude, focal depth, and attenuation effects. Several basic geologic maps were compiled from the literature and from unpublished drill hole data and show the known and inferred faults, topographic lineations, configuration of the base of the Cretaceous System, and configuration of the base of the Chattanooga Shale. As a result of these investigations the region was divided into five structural areas, defined principally by structural geology, which have different relative earthquake expectancy. The probable site of future high-intensity earthquakes is identified as the New Madrid Faulted Belt which contains the Reelfoot Tectonic Structure. The relative earthquake expectancy of the other four areas is discussed. (L.C.L.)

48069 (ORNL-TM-3804) PROGRAM PLAN FOR USAEC-RDT SEISMIC RESEARCH. Whitman, G. D.; Foster, J.; Robinson, G. C. Jr. (Oak Ridge National Lab., Tenn.). Jun 1972. Contract W-7405-eng-26. 112p. Dep. NTIS.

A program plan is provided for the selection and management of research and development tasks that may be useful in connection with the siting, design, testing, and operation of nuclear power plants. The task areas are identified as: regional and area investigations which include geologic and seismologic mapping, fault studies, and prediction of seismicity; site investigations dealing with soil and rock properties; design and analysis, i.e., studies of soil-structure interaction and of the strength and function of components and systems; and integral testing, or full-scale structure tests. The principal purpose of the areas of effort designated is the development of improved seismic design methods and information which would replace what may in the past have been overly conservative safe estimates. The organization of the program plan and priorities to be assigned to each task are included. (L.C.L.)

48070 (USGS-474-102) HYDRAULIC TESTS IN HOLE UAe-1, AMCHITKA ISLAND, ALASKA. Ballance, Wilbur C. (Geological Survey, Denver, Colo.). Jul 1972. 40p. Dep. NTIS.

Inflatable straddle packers were used to isolate and test 12 intervals of about 61 m (200 ft) each in hole UAe-1. Packer seats were very poor in the uncased part of the hole because of unstable wall conditions. Thus, some zones had to be tested several times. The static water levels in the intervals tested ranged from about 34 m (112 ft) below land surface in the upper interval to about 37 m (121 ft) below land surface in the lower interval, indicating decreasing head with depth. The relative specific capacities of isolated zones ranged from 0.007 m^3/d/m (0.0004 gpm/A) of drawdown to more than 5 m^3/d/m (0.3 gpm/ft) of drawdown. The lowest relative specific capacities were found below a depth of 1,922.1 m (6,306 ft). (auth)

Thermal Effluents

Refer also to abstracts 49889, 49890, 49900, 49905, 49912, 49923, 49935, and 49941.

48071 (ORNL-4797) AGRICULTURAL AND AQUACULTURAL USES OF WASTE HEAT. Yarosh, M. M.; Nichols, B. L.; Hirst, E. A.; Michel, J. W.; Yee, W. C. (Oak Ridge National Lab., Tenn.). Jul 1972. Contract W-7405-eng-26. 60p. Dep. NTIS.

Agricultural operations can utilize low-temperature (waste) heat from power plants without reducing electrical energy production. While these uses will not solve the thermal pollution problem, they can, in particular locations, reduce the impact of thermal effluents on the local ecology, conserve energy resources, and save money for both the electric utility and the farmer. Thermal effluents from power plants can be used in open-field-agriculture to promote rapid plant growth, improve crop quality, control pests and disease, extend the growing season, and prevent damage due to temperature extremes. Water, used for both irrigation and heating, can be applied through nozzles (spray irrigation) or through a subsurface piping system. With these systems the farm acts as a large, direct-contact heat exchanger for the power plant, while the utility provides irrigation water to the farmer. Several research projects are under way in the Pacific Northwest to investigate the feasibility and desirability of these systems. Some additional work is being performed in the Southeast. This use of heat is of importance for only a few days of the year (early spring and late fall). During the remainder of the year, water is needed for irrigation but not for heating. However, most power plants are sited near urban centers where rainfall is sufficient to obviate the need for irrigation. Also, the long-term implications of waste heat applications for soil management and disease and pest control are not yet known. The use of power plant waste heat for warming and cooling greenhouses can improve crop growth and yield while reducing operating (fuel) costs by as much as $4000 to $6000/acre. With approximately 7000 acres of greenhouse production today, this represents a total potential saving in fuel costs of $28 to $42 million annually on a national basis (10 to 30% of operating costs). Results of research at the University of Arizona, University of Sonora, and the Oak Ridge National Laboratory suggest that using waste heat for greenhouse climate control is both feasible and economically attractive. However, no large-scale field operations are currently under way. Waste heat can be used to provide optimal temperature control in swine and broiler houses. Fuel costs could be reduced by $8 million annually on a national basis. Additional savings in feed costs may result from improved feed efficiency under controlled environmental conditions. Additional study is required to determine the limitations imposed on agricultural uses by climate, geography, product marketing, waste heat reliability, effects of biocides and corrosion inhibitors in the cooling water, and consumer acceptance of products grown using cooling water from nuclear plants. It is essential that these problem areas be thoroughly investigated before a commitment is made to large-scale agricultural applications of waste heat. (auth)

48072 WINTER RESPONSES OF LARGEMOUTH BASS TO HEATED EFFLUENT FROM A NUCLEAR REACTOR. Gibbons, J. Whitfield; Hook, James T.; Forney, David L. (Savannah River Ecology Lab., Aiken, S. C.). Contract AT(31-1)-310. Progr. Fish-Cult.; 34: No. 2, 88-90(Apr 1972).

The effects of heated effluents from a nuclear reactor on largemouth bass living in the effluent reservoir were studied during Jan. and Feb. 1971 in two reservoir areas near the Savannah River Plant at Aiken, S. C. One area received heated effluents from a reactor. One did not. Bass were observed by underwater swimmers to determine population density and were caught by shore casting. 2800 casts were made. Each bass caught was measured for weight, standard length, and total length. Water temperatures at the shore and 5 m offshore were recorded before each series of casts. Significantly more fish were seen and caught in the vicinity of the heated effluent area than in the unheated areas. No differences were obvious in sizes of fish caught under the various conditions. It was concluded that effluent from a nuclear reactor unquestionably influences the activity of largemouth bass occurring in the vicinity during the winter. The numbers of fish caught and seen are apparently enhanced by the warm-water discharge. Further studies are required to determine the influence of factors other than temperature. (L.C.L.)

48073 HEATING OF THE RHINE RIVER BETWEEN BASEL AND THE GERMAN-DUTCH FRONTIER: A SIMULATION CONFIRMED BY MEASUREMENT. Mueller, R. E. (Motor-Columbus Electrical Management Co. Ltd., Baden, Switzerland). Energ. Tech.; 24: No. 4, 111-15(1972). (In German).

The simulation of the thermal effect of presently operating and of planned nuclear power plants, industrial plants, and of wastewater discharges into the Rhine on the water temperature of the river was carried out by a computer program, considering the natural cooling process. The computation of the time slope of the water temperature was made on the basis of the actual geometry and hydrological properties of the river system, of the measured meteorological conditions governing the environment as well as of the heating and heat flow originating either from sources of a technical nature, or from draining wells. The results were compared with measured temperatures. Subsequent to this verification of results, simulations were carried out and are discussed which considered both plants under construction and those being planned. (auth)

INSTRUMENTATION

Radiation Detection Instruments

Refer also to abstract 47654.

General Detectors and Monitors

Refer also to abstracts 47926, 48034, 48231, 49348, 49389, 49812, 49825, and 49982.

48074 (ANL–7291(Rev.1)) RADIATION SAFETY TECHNICIAN TRAINING COURSE. Moe, H. J.; Lasuk, S. R.; Schumacher, M. C.; Hunt, H. M. (Argonne National Lab., Ill.). May 1972. Contract W-31-109-eng-38. 517p. Dep. NTIS.

A revised course intended to complement on-the-job monitoring training for Health Physics technicians is presented. The initial five sections deal with basic information concerning atomic structure and physical quantities, natural radioactivity, properties of α, β, γ, x-rays, and neutrons, radiation units and external dose determinations, and shielding. Biological effects of radiation are noted, followed by discussions of background radiation, radiation protection standards, and internal dose calculations in the next four sections. The remaining eight sections cover topics dealing with certain aspects of radiation monitoring. Radiation detection principles, instrument operation and counting statistics, Health Physics instruments, and personnel monitoring devices are treated in separate sections. The last four sections deal with the nature of, principles of operation of, and monitoring approaches to air sampling, reactors, hot cells, and accelerators. All sections contain reference lists. Material was added in an attempt to make this revised edition more valuable as a text. Each section is followed by questions relating to the text material and, where appropriate, problems are also included. Appendices, including fundamental constants, signs and symbols, absorption coefficients, common logarithms, exponentials, natural logarithms, and the Chart of the Nuclides, appear. In addition, an index is included. (83 figures, 6 tables, 464 references) (auth)

48075 (BNL–16972) CONSTRUCTION OF MINIATURE, LOW-LEVEL PROPORTIONAL COUNTERS. Kummer, Fred H.; Stoenner, R. W.; Davis, Raymond Jr. (Brookhaven National Lab., Upton, N. Y.). 1971. 13p. (CONF-720635–1). Dep. NTIS.
From Annual symposium of American Scientific Glassblowers; Ottawa, Canada (27 Jun 1972).

The design and fabrication of low-level proportional detectors with very low background counting rates are described. These counters have been useful for counting very small amounts of ^{37,39,42}Ar, ^{14}C, ^{222}Rn, and T from such sources as meteorites and lunar samples, as well as in searches for solar neutrinos. The materials are selected to be as free as possible from naturally occurring radioactive contaminants. Even the smallest of these miniature counters (9.2 cm^3) has a counting efficiency approaching that of conventional internal gas counters. (2 figures) (R.W.R.)

48076 (N–72–20383) LARGE-AREA DETECTOR FOR NEUTRONS BETWEEN 2 AND 100 MeV. Grannan, R. T.; Koga, R.; Millard, W. A.; Preszler, A. M.; Simnett, G. M.; White, R. S. (California Univ., Riverside. Dept. of Physics). 1 Feb 1972. Contract N00014-69-A-0200-5001. 33p. (NASA-CR–125913). NTIS.

A neutron detector sensitive from 2 to 100 MeV is described. The detector is designed for high altitude balloon flight to measure the flux, energy and direction of albedo neutrons from the earth and to search for solar neutrons. A neutron scatter from a proton is required in each of two liquid scintillator tanks spaced 1 meter apart. The energy of the recoil proton in the first tank is obtained from pulse height analysis of the scintillator output. The energy of the recoil neutron is obtained from its time of flight between the tanks. The detector has been calibrated with 15.3 MeV neutrons and mu mesons. The minimum detectable flux is 10(−4) neutron/sq/ cm/sec at a counting rate of one per minute; the energy resolution is 12% at 15 MeV and 30% at 100 MeV. The angle between the incoming neutron and the recoil neutron is measured to + or −10 deg. (auth) (STAR)

48077 SUBATOMIC PARTICLE DETECTOR WITH LIQUID ELECTRON MULTIPLICATION MEDIUM. Alvarez, Luis W.; Derenzo, Stephen E.; Muller, Richard A.; Smits, Robert G.; Zaklad, Haim (to United States Atomic Energy Commission). U. S. Patent 3,659,105. 25 Apr 1972. Filed 21 Oct 1970.

A subatomic particle detector having a large number of equally spaced anode conductors arranged in a single plane opposite and parallel to a large cathode plate with the space between the anode conductors and cathode plate filled with liquid argon is described. A phototransistor is connected to each conductor for automatic readout of the detector by means of a laser beam that is scanned over each phototransistor. (auth)

48078 PREAMPLIFIER BASED ON A FIELD-EFFECT TRANSISTOR IN THE SRS-1-0 SCINTILLATION X-RAY COUNTER. Murashko, G. M.; Nikonenkov, N. V. (Central Scientific-Research Inst. of Ferrous Metallurgy, Moscow). Instrum. Exp. Tech. (USSR) (Engl. Transl.); 14: No. 5, 1580-1(1971).
Translated from Prib. Tekh. Eksp.; 14: No. 5, 261(1971).

A preamplifier based on a field-effect transistor is described which is built into the SRS-1-0 scintillation x-ray counter for the purpose of achieving a radical increase in the signal-to-noise ratio in powerful electromagnetic fields. (1 figure) (auth)

48079 METHOD FOR TRANSVERSAL TOMOGRAPHY USING GAMMA RADIATION. TRANSVERSAL TRANSMISSION GAMMA-TOMOGRAPHY. Rekonen, A. (Middle Finland Central Hospital, Jyvaeskylae, Finland). Commentat. Phys.-Math.; 42: 1-37(1972). Thesis.

A new transversal tomography procedure is introduced, where the radiation source is a gamma-ray emitting radionuclide and the detector a scintillation counter. The procedure involves transversal and rotary motion of the collimated gamma-ray beam at the emitter-detector unit relative to the subject. The modulation transfer functions are calculated for each component unit, for the motions and finally for the complete system. A comparison indicates that the developed transversal transmission gamma-tomography (TTGT) ranks in terms of image resolution above radioisotope scintigraphy though lower than roentgen transversal tomography. The radiation load in the TTGT process is clearly smaller than that of conventional X-ray or scintigraphic methods. Some results and photographs of phantom and patient tomograms are presented. (auth) (Finland)

48080 MEASUREMENTS OF RADIOACTIVITY IN BODY ORGANS. REPORT OF A PANEL OF EXPERTS OF THE INTERNATIONAL ATOMIC ENERGY AGENCY. Acta Radiol., Ther., Phys., Biol.; 10: No. 5, 525-40(Oct 1971).

This report was drawn up by a panel of nine experts convened by the International Atomic Energy Agency in December 1969 to discuss the techniques available for the measurement of radioactivity in body organs. A general review of the techniques available for such measurements is given, and the main problems which they entail are discussed. It deals in turn with measurement techniques based on the use of fixed detector systems, techniques based on whole-body radioactivity measurements, techniques based on the analysis of profile scanning data, and techniques based on the analysis of scintigraphic data. The present status of each technique is reviewed, its particular advantages and disadvantages are indicated and its main applications listed. Consideration is also given to the relative sensitivities of different techniques. (auth) (Sweden)

48081 BETA GAMMA SURVEY METER. Park, In Yong; Lee, Byung Suhn. J. Korean Inst. Electron. Eng.; 8: No. 1, 1-8(1971).

A survey meter which uses a G–M counter sensitive to beta and gamma radiation is studied. This device is completely transistorized, operates with battery, and can be read directly. It has full-scale meter ranges of 2.5, 25, and 250 mr/hr. The collector-coupled monostable multivibrator, consisting of a counting-rate meter circuit, and the astable blocking oscillator, consisting of a dc–dc converter for power supply, are analyzed and the design equations are derived. To improve the resolving time of the G–M counter the device is designed to be triggered by low pulses on the order of 0.5 V. (Korean Sci. Abstr.)

48082 LIQUID SCINTILLATOR COMPOSITIONS FOR GAMMA-RAY COUNTING. Benson, Royal H. (to Monsanto Co.). U. S. Patent 3,673,100. 27 Jun 1972. Filed 23 Apr 1969.

A scintillator composition and method for liquid scintillation detection and counting of gamma rays are described. The composition comprises a scintillator solution comprised of an aromatic hydrocarbon solvent, a scintillation solute, and an ethoxylated alkyl phenol and a loading agent comprised of an aqueous solution of a compound of an element having an atomic number greater than twenty. (auth)

48083 STABLE, LOW LEVEL RADIATION MONITOR. Thiele, Tom N.; Gerlach, Lester O.; Gilmore, Thomas P.

(to Allis-Chalmers Manufacturing Co.). U. S. Patent 3,671,746. 20 Jun 1972. Filed 2 Jun 1970.

A radiation monitor is described which has a low-loss integrating capacitor charged by the output of a radiation sensor, a high-input-impedance operational amplifier operating in the inverting mode connected across the integrating capacitor, and a reference voltage source applied to the noninverting input, whereby the operational amplifier is initially in positive saturation and switches to negative saturation when the voltage across the capacitor equals the reference voltage. Means responsive to the negative saturation output of the operational amplifier are provided to discharge the integrating capacitor and to generate a pulse, and a pulse counter gives an indication of total radiation received by the sensor. A second high-input-impedance operational amplifier operating in the inverting mode has its inverting input connected to one electrode of the integrating capacitor and holds it at zero potential, and a current meter driven by the output of the second operational amplifier provides an analog indication of the current from the radiation sensor flowing through the integrating capacitor and is calibrated in roentgens per minute received by the sensor. (3 figures) (auth)

48084 UP-DOWN COUNTER FOR BACKGROUND COMPENSATION. Splichal, William F. Jr. (to United States Atomic Energy Commission). U. S. Patent 3,666,953. 30 May 1972. Filed 18 Aug 1970.

A radiation monitor that provides a signal when contamination exceeds a minimum allowable proportion of background radiation is described. The monitor includes two sensors for separately measuring background and the total of background and contamination radiation. An up-down counter accumulates only background count for an initial time interval—then it deducts the total count for a second time interval while continuing to accumulate background count. An adjustable timer allows the initial-to-second-time-interval ratio to be adjusted to set the appropriate contamination-to-background ratio. An alarm is activated if the contamination-to-background ratio exceeds the preset value. (2 figures) (auth)

48085 POLYCRYSTALLINE SEMICONDUCTOR-METAL SURFACE BARRIERS AS RADIATION RESISTANT PROBES FOR THE DETERMINATION OF HIGH THERMAL NEUTRON FLUX DENSITIES. Graul, J. Munich; Technische Univ. (1970). 82p. (In German).

Thesis.

A PtSi–Si surface barrier coated with B as conversion material is described. For neutron flux densities from 10^9 up to 10^{14}/cm^2 sec, a maximum operational life of 20 days is obtained, and up to 8 months for photocurrent densities of 0.1 μA/cm^2. The operational life is not limited by radiation damage of the semiconductor but by problems due to the burnup of the conversion material. For application within a reactor, two probes in a compensating circuit have to be employed, one without conversion coating in order to eliminate the gamma background because of the low neutron-gamma ratio of the probe. The fabrication of amorphous and polycrystalline PtSi-Si layers by sputtering on a heated substrate as well as carbidization of Si by pyrolysis of methane and the subsequent coating with "metallic" TiC layers via gas phase reactions are described. (INIS)

48086 LIQUID SCINTILLATORS. Shamoo, Adil E. U. S. Patent 3,676,360. 11 Jul 1972. Filed 30 Jun 1971.

The counting efficiency of liquid scintillators containing toluene as the solvent for a primary solute or activator and for a secondary solute or spectrum shifter is improved, particularly in the presence of water, for example, when the isotope to be detected is in an aqueous solution, by adding to the liquid scintillator a hygroscopic substance which is soluble in toluene in an amount sufficient to absorb and/or emulsify the water that is present. Such hygroscopic additive is preferably cellulosic and may be selected from the group consisting of cellulose, carboxymethyl cellulose, cellulose phosphate, diethylaminoethyl cellulose, benzyl diethylaminoethyl cellulose, and epichlorohydrin triethanolamine cellulose. The additive for improving the counting efficiency may advantageously include, apart from the cellulose and/or cellulose derivative, a small amount of sodium or calcium carbonate or bicarbonate. The improvement in counting efficiency resulting from the mentioned addition is particularly large when the scintillator liquid includes alcohol as well as toluene. (auth)

48087 LOW ENERGY PARTICLE COUNTER WITH TWO-DIMENSIONAL POSITION SENSING. Somer, Toivo A. (to Bendix Corp.). U. S. Patent 3,676,676. 11 Jul 1972. Filed 30 Oct 1970.

A system for detecting radiant energy, such as photons or charged particles, and yielding an output which is indicative of the position in the x, y plane of the input surface of the detection element at which the energy impacts the detection element, is described. The system includes a radiation detector, which is subjected to the radiant energy and which yields an output charge in response to it. The output charge energizes several charge-sensitive elements, which give an indication of the position at which the radiant energy impacts the detection element in one direction. A second set of charge-sensing elements is also energized by the output charge to yield a position indication in the other direction. The individual outputs from the two sets of charge-sensitive elements can, therefore, be combined to indicate the position along two orthogonal axes at which the detected radiant energy impacted the radiation-sensitive element. (2 figures) (auth)

48088 PERFORMANCE OF ELECTRON MULTIPLIERS IN FIM ATOM PROBES. Brenner, S. S.; McKinney, J. T. (United States Steel Corp., Monroeville, Pa.). Rev. Sci. Instrum.; 43: No. 9, 1264-7(Sep 1972).

To produce reliable results, the particle detector in the time of flight spectrometer section of the FIM atom probe must detect all the particles incident on it, and must not generate extraneous pulses which might be misinterpreted as primary events. Three detectors of the continuous dynode type—the curved Channeltron multiplier, the magnetic strip multiplier, and the parallel channel plate multiplier—were tested in an FIM atom probe using 7 keV field ionized neon atoms as the detected particles. Under normal operating conditions all three detectors exhibited some afterpulsing, which increased rapidly with increasing gain. At low gains the broadened pulse height distribution makes detection of some of the events uncertain, and a compromise must be made between afterpulsing and detection efficiency. Only the curved Channeltron could be operated at high gains with a tolerable incidence of after pulsing (<3%) by changing the potential configuration at the input end of the detector. The time between the primary pulse and the afterpulses differed for the different multipliers. With the magnetic multiplier this time interval was the longest—about 350 nsec—and thus the afterpulses could be mistakenly attributed to metal compound ions when this multiplier is used. (auth)

48089 SPIRAL ELECTRON MULTIPLIER OPERATION CHARACTERISTICS USING POSITIVE IONS. Potter, Wentworth E.; Mauersberger, Konrad (Univ. of Minnesota, Minneapolis). Rev. Sci. Instrum.; 43: No. 9, 1327-30(Sep 1972).

Operational characteristics of a spiral electron multiplier are discussed, and measurements of gains and detection efficiencies using positive ions are presented. These parameters were observed during lifetime tests on two multipliers. Gains above 10^7 were found up to 10^{11} accumulated counts. The detection efficiencies for ions in the mass region from 4 to 40 amu varied between approximately 60% and 90% for incident energies of 3–4.5 keV. (auth)

48090 MICRODETECTOR OF VERY LOW INTENSITY PULSED X-RAYS. Kaminishi, T. (Government Industrial Research Inst., Nagoya, Japan). Genshiryoku Kogyo; 18: No. 2, 33-8(Feb 1972). (In Japanese).

Shielded NaI detectors were used to measure the low-level leakage x-ray spectra from electron linac pulsed x-ray sources. A synchronous gate method was used to count pulses only during the generation of the pulsed x-ray. (TSS)(Japan)

48091 5- TO 10-MeV PORTABLE PHOTON SURVEY METER. Shipler, D. B.; Sheen, E. M. (Battelle-Northwest, Richland, Wash.). Health Phys.; 23: No. 2, 247-50(Aug 1972).

A portable NaI(Tl) detector was developed to identify areas of high energy photon exposure and to indicate the high energy photon exposure rate occurring during the operation of reactors due to photons streaming from the bore patterns of the core and also present in the effluent air and water. The instrument will operate in fields of about 200 mR/hr of lower energy photon radiation (^{60}Co, radium gamma, and activation background) without appreciable pile-up. The instrument will discriminate against these lower energies and still show high count rates (8.0 × 10^6/min) for photons of energies above a preset level (about 5 MeV during field testing). (UK)

48092 APPLICATION OF A FRESNEL ZONE PLATE TO GAMMA-RAY IMAGING. Rogers, W. L.; Han, K. S.; Jones, L. W.; Beierwaltes, W. H. (Univ. of Michigan, Ann Arbor). J. Nucl. Med.; 13: No. 8, 612-15(Aug 1972).

A Fresnel zone plate was used with radioactive point sources and an image intensifier camera for gamma-ray imaging. The experimental setup is described and preliminary data are discussed. The study indicates that a Fresnel zone plate shows promise for gamma imaging in nuclear medicine. (W.H.K.)

48093 TRACK-EFFECT ACCOUNT OF SCINTILLATION EFFICIENCY FOR RANDOM AND CHANNELED HEAVY IONS

OF INTERMEDIATE VELOCITIES. Luntz, Myron; Heymsfield, Gerald M. (State Univ. of New York, Fredonia). Phys. Rev., B; 6: No. 7, 2530-6(1 Oct 1972).

The high-velocity formulation of the track-effect theory of scintillation efficiency is generalized for applicability at intermediate velocities (velocities spanning the peak in dE/dx) and applied to room-temperature data for ^{16}O in NaI(Tl) both for random and channel trajectories. A core-correction term is incorporated into the representation of dE/dx. Electron velocities are taken into account in the calculation of track width $R_{max}(v)$. The contribution to dL/dE from the region of high energy-deposit density is included. Quantitative agreement within experimental error is achieved for the ^{16}O random-response data over the range $0.9 \leq v \leq 3.6$, where v is in units of 10^9 cm/sec, including the region of intermediate velocities characterized by a reversal of curvature and leveling off of dL/dE. The channel response is treated only so far as to indicate applicability of the theory. Values for the ratio [dL/dE(channel)]/[dL/dE(random)] are accounted for both in approximate magnitude and qualitative dependence on particle velocity. (auth)

48094 WINDOWLESS PROPORTIONAL COUNTER FOR SOFT X-RAYS. Kifune, T.; Kawashima, N. (Tokyo Univ.). Nucl. Instrum. Methods; 103: No. 1, 167-8(1972).

A new windowless proportional counter is described in its preliminary stage. This counter will be applicable as a very soft radiation detector in the field of X-ray astronomy. (auth)

48095 ΔE GAS IONIZATION CHAMBER FOR FISSION FRAGMENTS. Ajitanand, N. N.; Kataria, S. K.; Kapoor, S. S.; Rama Rao, P. N. (Bhabha Atomic Research Centre, Trombay, India). Nucl. Instrum. Methods; 103: No. 1, 169-70(1972).

A method of collimating and separating light and heavy fragments using a simple gas ionization device is described. Results obtained with a californium-252 spontaneously fissioning source are presented. (auth)

48096 COMMENT ON DIGITAL CORRECTOR FOR MULTICHANNEL COUNTING OF SHORT- AND MEDIUM-LIVED NUCLIDES. Rao, D. N.; Glen, J. L.; Taylor, D. (Univ. of Strathclyde, Scotland). Nucl. Instrum. Methods; 103: No. 1, 175-7 (1972).

This note comments on the recent paper by Görner (Nucl. Instr. and Meth. 98(1972) 371) and suggests an alternative interpretation of his circuit based on the use of binary rate devices and perhaps indicates some simplifications which might be made. (auth)

48097 SOME PROPERTIES OF MULTIWIRE CHAMBERS FILLED WITH ARGON–ETHYLBROMIDE MIXTURE. Cohen, L.; Grunberg, C.; Le Devehat, J. (CEN, Saclay, France). Nucl. Instrum. Methods; 103: No. 1, 125-33(1972).

The performances of multiwire chambers filled with an argon–ethylbromide mixture are described. Such a mixture is suitable to operate in the proportional or semiproportional mode as soon as the ethylbromide concentration is sufficiently high. The properties, due to the gaseous mixture, are emphasized. Also, the effect of geometrical characteristics which are available for any chamber given is shown. (auth)

48098 EFFECT OF MULTIPLE SCATTERING IN A GAS ON THE SOLID ANGLE SUBTENDED BY A CIRCULAR APERTURE. Jaffey, A. H. (Argonne National Lab., Ill.). Nucl. Instrum. Methods; 103: No. 1, 141-7(1972).

With a gas-filled space between a circular aperture and an alpha-emitting point source on its axis, the effective geometry may differ from the subtended solid angle because of multiple scattering in the gas. This is an effect which may be of some importance in certain precision absolute alpha counters such as the Argonne IGAC. Using the known theory of multiple scattering, the effect was calculated generally. As applied to IGAC, the effect is not important for the usual operating conditions, although it could be significant under other conditions or in other counters having gas absorption between source and defining apertures. (auth)

48099 LARGE AREA DETECTOR FOR NEUTRONS BETWEEN 2 AND 100 MeV. Grannan, R. T.; Koga, R.; Millard, W. A.; (and others) (Univ. of California, Riverside). Nucl. Instrum. Methods; 103: No. 1, 99-108(1972).

A neutron detector sensitive from 2 to 100 MeV is described. The detector is designed for high altitude balloon flight to measure the flux, energy and direction of albedo neutrons from the earth and to search for solar neutrons. A neutron scatter from a proton is required in each of two liquid scintillator tanks spaced 1 m apart. The energy of the recoil proton in the first tank is obtained from pulse height analysis of the scintillator output. The energy of the recoil neutron is obtained from its time of flight between the tanks. The detector has been calibrated with 15.3 MeV neutrons and μ-mesons. The minimum detectable flux is 10^{-4} neutron/cm^2 s at a counting rate of one per minute, the energy resolution is 12% at 15 MeV and 30% at 100 MeV. The angle between the incoming neutron and the recoil neutron is measured to ±10°. (auth)

48100 LOCAL EFFICIENCY VARIATIONS IN COAXIAL Ge(Li) DETECTORS. Sherman, I. S.; Strauss, M. G. (Argonne National Lab., Ill.). Nucl. Instrum. Methods; 103: No. 1, 113-15(1972).

Substantial variations in full energy peak efficiency were observed when a 1 mm γ-ray beam of 122 keV from ^{57}Co was directed at a series of points across the face and along the axis of an open-ended true coaxial detector. The full energy peak efficiency near the n-layer was measured to be less than 50% of that near the p-core. As the peak efficiency decreases across the intrinsic region, the continuum below the peak (0 to 117 keV) increases, so that the total counts in the spectrum remain essentially constant over the sensitive area. This non-uniform response is thought to be due primarily to imperfect compensation resulting in recombination and therefore incomplete charge collection. (auth)

Radiation Dosimeters

48101 (CEA-N-1510) RESPONSE TO PULSED IRRADIATION OF SEVERAL TYPES OF DOSIMETERS USED IN HEALTH PHYSICS. (Commissariat a l'Energie Atomique, Fontenay-aux-Roses (France). Centre d'Etudes Nucleaires). Apr 1972. 34p. (In French). Dep. NTIS (U. S. Sales Only).

The response of several types of dosemeters (including photographic film dosimeters, alanine chemical dosimeters, and several ionization chambers) exposed to pulsed radiation from different flash x-ray generators was studied. The performance of these dosemeters is given as a function of the dose per pulse. With certain ionization chamber detectors, the results are not completely explained by ionic recombination. The interpretation of these results is discussed. (France)

48102 (DUN-SA-172) MONETARY GAINS FROM ADVANCEMENTS IN PERSONNEL RADIATION MONITORING. Owen, F. E. (Douglas United Nuclear, Inc., Richland, Wash.). 31 Mar 1971. 4p. Dep. NTIS.

Instrumentation for personnel dose and dose rate monitoring is described including self-reading pocket ion chambers, fixed location alarm systems, the pocket alarm rate dosimeter, and the pocket alarm dose integrator. The use of these self-reading dosimeters makes it unnecessary for radiation safety personnel to stay with workers in the radiation zone, and therefore significant savings in manpower result. (W.H.K.)

48103 RATIO CIRCUIT FOR PLOTTING DOSE DISTRIBUTION IN THE RADIATION FIELD OF THE 8 MV M.E.L. LINEAR ACCELERATOR. Planskoy, B. (Middlesex Hospital, London). Brit. J. Radiol.; 45: No. 535, 543-6(Jul 1972).

A circuit is described which provides an analog voltage output proportional to the ratio of two input currents. The first output current is derived from the ionization chamber built into the head of an 8 MV linear accelerator (M.E.L. SL-75), the second from a probe ionization chamber which can be moved during exposure. The complete system is composed of commercially available units, save for the actual ratio box, and the solid state circuit for the latter is given in detail. Central axis x-ray depth dose curves in a water phantom, derived from the current ratio trace on a chart recorder, agreed within 0.6% with a Farmer dosemeter point by point at all depths up to 25 cms. The trace took 3 min, whereas the Farmer dosemeter measurements took up to 1 hr. Similar comparisons for cross field plots showed agreement down to the 5% level. The current ratio trace along a line gave sufficient input data for an on-line computer calculation of full isodose curves. (UK)

48104 MIXED FIELD RADIATION DOSIMETER MATERIALS OF AMINE SALTS OF ORGANIC ACIDS. Peters, Ignatius G. (to Secretary of the Air Force). U. S. Patent 3,673,107. 27 Jun 1972. Filed 18 Dec 1969.

Amine salts of organic acids are used as dosimeter materials. The salts react with mixed-field ionizing radiation to form stable free radicals, which may be detected by the technique of electron spin resonance spectroscopy. The salts have hydrogen contents of from about 9 to about 11 weight percent and thus react with ionizing radiation in a manner similar to human tissue which has about 10 weight percent hydrogen. The materials are useful in studying the effect of radiation on tissue. (auth)

48105 CHARACTERISTICS OF THERMOLUMINESCENT DETECTORS IRRADIATED WITH FAST ELECTRONS. Czakowski, Peter-Michael (Univ. of Saarland, Saarbruecken, Ger. Boris Rajewsky Inst., Homburg, Ger.). Stud. Biophys.; 23: No. 2, 101-8(1970). (In German).

A simplified process for the heat treatment of thermoluminescent crystals is described. The energy dependence and the linearity of CaF$_2$ and LiF were investigated by irradiation with electrons in the range 5 to 44 MeV. The results showed that LiF crystals in particular were well suited for measuring the dose distribution in phantoms and likewise in vivo. (4 figures) (R.W.R.)

48106 INTERCOMPARISON OF THE ACCURACY OF DOSIMETRY SYSTEMS USED IN THE DIFFERENT FACILITIES. Tatsuta, Hatsumi (Japan Atomic Energy Research Inst., Tokai); Moriuchi, Yasuyuki; Katoh, Akira; Yamachi, Iwao; Matsumoto, Ken. Hoken Butsuri; 7: No. 1, 37-41(Mar 1972). (In Japanese).

The accuracy in measuring external doses by a variety of dosimeters in different facilities is described. The standard irradiation of dosimeters was carried out at the Electrotechnical Laboratory of the Ministry of International Trade and Industry, and the measurement of doses was done by the film-service section in each facility. The precision of both film badge and glass dosimeter systems under the best condition was about 3% standard deviation in the range of dose from 100 mR to 500 mR. The film badge was more precise than the glass dosimeter at lower dose (less than 100 mR), whereas the glass dosimeter gave better results at higher dose (more than 1000 mR). (auth) (Japan)

48107 THERMOLUMINESCENCE DOSIMETER (TLD). 2. CONSTRUCTION AND CHARACTERISTICS OF CaSO$_4$: Tm TLD. Yamashita, Tadaoki; Onishi, Hajimu; Yasuno, Yoshitake; Takenaga, Mutsuo; Yamamoto, Osamu (Matsushita Electric Industrial Co. Ltd., Osaka). Nat. Tech. Rep. (Matsushita Elec. Ind. Co., Osaka); 18: No. 2, 171-80(Apr 1972). (In Japanese).

Thermoluminescent dosimeters were designed and constructed using Tm activated calcium sulfate phosphor. For personnel monitoring applications, two thermoluminescent elements were secured to a case and an easy to handle dosimeter was obtained. An energy compensation shield composed of alloyed metal strips arranged cylindrically was designed to measure exposure. The main characteristics are: (1) flat response for exposure from 30 keV to 6 MeV with a tolerance of ±15%; (2) small directional response with a tolerance of ±40% at 50 keV and 100 keV, or ±50% at 30 keV; (3) linear response from 0.1 mR to 200 R; and (4) stable for more than 100 cycles of repeated uses. (auth) (Japan)

48108 MEASUREMENT OF MEAN QUALITY FACTOR BY LET SPECTROSCOPY. Hancock, S. S.; Oliver, G. D. Jr. (Anderson Hospital and Tumor Inst., Houston, Tex.). Health Phys.; 23: No. 2, 250-3(Aug 1972).

In evaluating the relative hazards from radiation exposure, the problem of specifying an appropriate quality factor (QF) for the radiation field arises. A method is described whereby the mean quality factor ($\bar{Q}$F) is obtained by evaluation of the fractional absorbed dose, D(L), due to all particles having any LET, L, for a given total absorbed dose, D. The experimental evaluation of D(L) using a spherical proportional counter is described. The sources of error in this method of measurement of $\bar{Q}$F are enumerated and discussed. (UK)

48109 OPTICAL AND THERMAL EFFECTS ON THERMOLUMINESCENCE RESPONSE OF Mg$_2$SiO$_4$(Tb) AND CaSO$_4$(Tm) PHOSPHORS. Nakjima, T. (National Inst. of Radiological Sciences, Chiba, Japan). Health Phys.; 23: No. 2, 133-6(Aug 1972).

Optical and thermal effects on the response of CaSO$_4$(Tm) and Mg$_2$SIO$_4$(Tb) were investigated. In the case of illuminating with light, thermoluminescence of CaSO$_4$(Tm) is hardly affected but the TL intensity of Mg$_2$SiO$_4$(Tb) is about 600 times as great as the background noise. Optical fading of Mg$_2$SiO$_4$(Tb) is dependent on the wavelength of the illuminating light; however, in practice, optical effects on the response of the phosphor in an opaque holder is negligible. The response of these phosphors is scarcely dependent on irradiating temperature from 0 to 40°C. A build-up of response in Mg$_2$SiO$_4$(Tb) is found. (auth) (UK)

48110 LITHIUM FLUORIDE GLOW-PEAK GROWTH DUE TO ANNEALING. Booth, L. F.; Johnson, T. L.; Attix, F. H. (Naval Research Lab., Washington, D. C.). Health Phys.; 23: No. 2, 137-42(Aug 1972).

After a normal readout operation the heights of the LiF TL glow peaks in the vicinity of 200°C, usually employed for dosimetry, display a marked growth as a function of storage time occurring either before or after a given γ-ray exposure. This is probably caused by the migration and aggregation of simple, low-temperature trapping centers into more complex, higher-temperature centers. The magnitude of the effect depends on the population of low-temperature traps present, and on the readout heating-rate employed. (auth) (UK)

48111 AN INEXPENSIVE TLD PERSONNEL BADGE. Gollnick, D. A. (California State Coll., Los Angeles). Health Phys.; 23: No. 2, 255-7(Aug 1972).

An inexpensive LiF TLD personnel badge suitable for monitoring students was constructed from readily available materials. Low initial cost and ease of processing the badge are desirable features for a modest radiation protection program. The badge sensitivity exhibits some directional dependence, but the variations measured are within acceptable limits for use as a student personnel badge. (UK)

48112 USE OF THERMOLUMINESCENT DOSIMETERS FOR MEASUREMENT OF DOSE TO THE HANDS OF NUCLEAR MEDICINE TECHNICIANS. Anderson, D. W.; Richter, C. W.; Ficken, V. J.; Adams, G. D. (Univ. of Oklahoma, Okahoma City). J. Nucl. Med.; 13: No. 8, 627-9(Aug 1972).

Measurements of the dose equivalent to the fingers of nuclear medicine technicians are reported and discussed. Rings containing thermoluminescent dosimeters were used so the measurements could be made under actual working conditions. The dose equivalent measured was correlated with the amount of activity handled. The average superficial dose equivalent accumulated during injection of ^{99m}Tc agents with standard syringes was about 1,600 mrems/Ci injected. This value is for the index finger of the right hand. Other fingers sustained considerably less exposure. The dose equivalent due to elution, calibration, and preparation was about 200 mrems/Ci eluted. (auth)

48113 DOSIMETRY OF HEAVY CORPUSCULAR RADIATION (Z ≥ 2) BY MEANS OF NUCLEAR EMULSIONS AND SOLID DETECTORS OF TRACKS. Haseganu, D.; Nicolae, M. (Inst. of Atomic Physics, Bucharest). Rev. Roum. Phys.; 17: No. 1, 93-100(1972). (In French).

The method of heavy corpuscular radiation dosimetry proposed allows to divide the ion spectrum into several ionization groups using high sensitivity nuclear emulsions and a discriminating development (Amidol and NaSCN developer). A comparison with a cellulose nitrate detector is made, after which it is concluded that the proposed method is more efficient and versatile, the relativistic proton background being avoided also. The method of dose establishing is also presented. (auth)

Nuclear Spectroscopic Instrumentation

Refer also to abstracts 48295, 48547, and 50022.

48114 (CEA-N-1525) PROTON RECOIL PROPORTIONAL COUNTERS SPECTROMETRY. Leridon, Alain; Werz, Rudolph; Jeandidier, Claude; Calamand, Daniel; Schmitt, Andre Paul; Comte, Roger (Commissariat a l'Energie Atomique, Cadarache (France). Centre d'Etudes Nucleaires). Mar 1972. 95p. (In French). Dep. NTIS (U. S. Sales Only).

A fast neutron spectrometer using proton recoil proportional counters is described. An energy range from a few keV up to 1.5 MeV can be studied. The detectors, electronics (in particular the neutron gamma discrimination system), and the analysis codes are discussed. Some spectrum measurements were performed in various media, e.g., in the field of fast neutron reactors. (France)

48115 (EUR-4831) SPECTROMETER, USING NaI(Tl)-Ge(Li) DETECTORS IN COINCIDENCE AND ANTICOINCIDENCE FOR (n,GAMMA) INVESTIGATIONS. Heske, M. (European Atomic Energy Community, Geel (Belgium). Central Nuclear Measurements Bureau). 27 Mar 1972. 16p. Dep. NTIS (U. S. Sales Only). EUR B.Fr. 40.-.

Two modifications of the well known pair spectrometer are described. In one modification, the energy condition for one totally absorbed annihilation gamma quantum (511 ± 70 keV) has to be fulfilled in only one of the two single channel analyzers. In the other modification, only fast triple coincidence is required without any pulse height conditions. Also, the Compton suppression or anticoincidence mode was studied. To compare the different modes, measurements were carried out with ^{56}Co, ^{10}B(α,pγ)^{13}C, and ^{22}Na sources. Higher efficiencies in the double escape peaks were achieved and therefore the measuring time was reduced using the two modified modes. (W.H.K.)

48116 (JAERI-M-4590) ANALYTICAL FUNCTION FOR DESCRIBING THE RESPONSE FUNCTION FROM NaI(Tl) DETECTOR SYSTEMS FOR GAMMA-RAYS. Sekine, Toshiaki; Baba, Sumiko; Baba, Hiroshi (Japan Atomic Energy Research Inst., Tokyo). Sep 1971. 40p. (In Japanese). NTIS (U. S. Sales Only).

An analytical function for describing the response function for gamma rays of a NaI(Tl) detector system was developed with the purpose of establishing the method of automatic gamma-ray analysis. The response was found to be divided into six portions; the function of each portion joins smoothly the function representing the adjacent portion. The gamma-ray energy dependence of parameters specifying the functions was determined experimentally. The response function obtained was fitted to the observed spectrum by the method of least squares. The calculated value agreed well with the observed one, in which a measure of the degree of fit was introduced, giving a result consistent with visual inspection. The spectrum composed of two gamma-rays artificially synthesized was analyzed by the least-squares and the graphical photopeak methods. The peak area by least-squares fit was found to be better than that by the graphical photopeak method. The base-line shift of the pulse with the source intensity was examined for two NaI(Tl) detectors. Considerable base-line shift was observed in one detector, whereas there was practically none in the other. (Japan) (auth)

48117 (LA-DC-72-525) NEW SYSTEM FOR GAMMA SCANNING FUEL ELEMENTS. Phillips, J. R.; Waterbury, G. R.; Mottaz, G. H.; Quintana, J. N. (Los Alamos Scientific Lab., N. Mex.). 1972. 23p. (CONF-720903-10). Dep. NTIS.

From twentieth remote systems technology conference; Idaho Falls, ID. (17 Sep 1972).

A new gamma scanning system for the nondestructive examination of irradiated fuel elements was installed at the Los Alamos Scientific Laboratory. Studies were conducted to optimize the operating parameters of the scanning mechanism, collimating slits, detector assembly, and data acquisition unit. The total system represents the state-of-the-art for thorough, detailed gamma scanning with high precision and also speed and ease of throughput. The success of the system is a consequence of incorporating the optimum designs, as indicated by the extensive studies, and also of fully automating the equipment by interfacing a small digital computer for system control and analysis. (auth)

48118 (UCRL-51206) MEASUREMENT OF X-RAY PULSES USING HYDRATED ELECTRONS. Coutts, Gerald W. (California Univ., Livermore. Lawrence Livermore Lab.). 1 Jun 1972. Contract W-7405-eng-48. 26p. Dep. NTIS.

A discussion of the role of the hydrated electron in a transient dosimetry system is given. The pertinent rate equations for this system are presented and practical assumptions are made concerning a simple theoretical solution for the system. This solution is compared with empirical results. The experimental arrangement is described. (auth)

48119 MEASUREMENT OF LONGITUDINAL POLARIZATION OF BETA RAYS USING A LENS SPECTROMETER AND INNER-SHELL IONIZATION BY PROTONS. Sharma, Deva Datta. Reno, Nev.; Univ. of Nevada (1971). 119p. University Microfilms Order No. 72-19,470.

Thesis.

The generally accepted V-A theory of weak interactions predicts a v/c dependence for the longitudinal polarization of beta rays. A precision determination of the longitudinal polarization of the beta particles from a $0^- \rightarrow 0^+$ transition is needed in order to exclude the possibility of small deviations from the v/c dependence which may be due to the pseudoscalar coupling or due to other types of couplings. A method for measuring the longitudinal polarization of beta rays using a lens spectrometer is described. The method is based on the spin dependence of the differential cross section for Moeller (Bhabha) scattering. The electron beam of unknown polarization is scattered from a magnetized ferromagnetic foil. The electron-electron scattered events are detected by a fast coincidence circuit. The direction of magnetization of the foil is reversed and the asymmetry in the coincidence count rates before and after reversal of the foil magnetization is measured. The unknown polarization is obtained from the measured asymmetry and other parameters related to the foil magnetization. The low coincidence count rates were overcome by using a long lens beta-ray spectrometer to focus the scattered electrons. The asymmetry obtained is, however, quite low compared to the asymmetry measured by other groups. Because of the low value of the asymmetry polarization values could not be extracted. The reasons for the low value of the asymmetry and the advantages of using a long lens beta-ray spectrometer for measuring the longitudinal polarization are discussed. In the second experiments, the measurement of silver, iodine and lead at the nanogram level was investigated. The method is based on measuring the characteristic x-ray spectra which result from the passage of the protons through the samples. The x-ray emission is induced by a 1.2 MeV proton beam from a Van de Graaff generator. A high resolution Si(Li) spectrometer is used for measuring the x-ray spectra. The L x-ray spectra obtained from the standard samples of silver, iodine and lead are discussed. The problems of background and the backing material are considered. The lower limits of detection at present are: Ag 10^{-8}g, I 6×10^{-10}g, and Pb 10^{-9}g. The sensitivity achieved was slightly better than that obtained by using high energy (~30 to 50 MeV) alpha particles. It is concluded that this method of elemental trace analysis has the potentiality of becoming a powerful tool for routine analysis of Ag, I and Pb in precipitation samples. (Diss. Abstr. Int., B)

48120 QUENCHING OF RADIOFREQUENCY INDUCED SIDE BANDS IN MOESSBAUER SPECTRA. Albanese, G. (Univ., Parma, Italy. CNR, Parma, Italy); Asti, G.; Rinaldi, S. Lett. Nuovo Cim.; 4: No. 6, 220-2(10 Jun 1972).

It has been shown that the application of a strong rf magnetic field on nonpowdered absorbers induces side bands in the Moessbauer spectrum, which have been attributed to ultrasounds excited by magnetoelastic interaction. Conditions for the most efficient quenching of the side bands were obtained theoretically. The results were checked by using a 13-μm iron foil irradiated with a 14-MHz magnetic field. Covering the sample with a thin layer of silicone grease completely eliminated the side bands. (2 figures) (R.W.R.)

48121 NEW HIGH-DISPERSION HIGH-RESOLUTION THREE-CRYSTAL X-RAY SPECTROMETER. Hrdy, J. (Inst. of Solid State Physics, Prague). Czech. J. Phys.; 22: No. 7, 627-9 (1972).

A new kind of three-crystal spectrometer is designed. The first two crystals are set in anti-parallel position, which remains constant during measurement. The third crystal is rotated along the horizontal axis perpendicular to the beams leaving the second crystal. Diffraction planes of the first two crystals are assumed to be vertical. The plane of incidence of the third crystal is then also vertical. Since this instrument permits greatly increased resolution and dispersion, no extreme mechanical precision is required. (auth)

48122 ANALYSIS OF COUNTING DISTRIBUTIONS WITH A COMPLEX EXPONENTIAL CHARACTER. Lichtenberger, P. C.; Stevens, J. R.; Newton, D. (Univ. of Guelph, Ont.). Can. J. Phys.; 50: No. 4, 345-51(15 Feb 1972).

The analysis of counting distributions which can be analytically represented by a sum of exponential functions convoluted with a "prompt instrumental resolution function" has attracted much attention in the past. Because of the difficulty of unfolding the prompt resolution function from the experimental data, experimentalists have analyzed that part of the distribution which occurred at times longer than the time at which the peak of the distribution occurred. A model is proposed which permits the prompt resolution function to be unfolded and the entire counting distribution, analyzed in cases where the prompt resolution function can be approximated by a double-sided exponential. The model is tested on Monte-Carlo simulated data. An algorithm which combines the best features of the gradient search and the Taylor-series search is used to obtain a least-squares estimation of the nonlinear parameters. Since the correct parameters are known, a realistic estimation of the errors associated with the analysis is obtained. (auth)

48123 LINE-SHAPE ON THE HIGH ENERGY SIDE IN SCINTILLATION GAMMA-SPECTROSCOPY. Berenyi, D.; El-Nasr, S. A. H. S.; Kadar, I.; Ujhelyi, Cs. ATOMKI (At. Kut. Intez.) Kozlem.; 14: No. 1-2, 1-9(1972).

The effect of the presence of an intensive gamma-ray on observing a lower intensity radiation in the spectrum at the higher energy side of the intensive spectrum-line was experimentally studied using a ^{54}Mn and a ^{7}Be source. It is stated that the original shape of the line has a small role in this problem, but the pile-up and the background are important factors. (auth)

48124 DEAD-TIME CORRECTION SYSTEM FOR GAMMA-RAY SPECTROMETRY OF SHORT-LIVED ISOTOPES. Bartosek, J. (Inst. of Applied Geophysics, Brno); Adams, F.; Hoste, J. Nucl. Instrum. Methods; 103: No. 1, 45-7(1972).

A method, based on the automatic creation of additional dead time at the end of very short measuring intervals so as to keep the total dead time constant, is proposed for the dead-time correction in gamma-ray spectrometry of short-lived isotopes. (auth)

High Energy Physics Instrumentation

Refer also to abstracts 48494 and 48549.

48125 (ANL/HEP–6813) SUPERCONDUCTING MAGNET SYSTEM FOR THE ARGONNE 12-FOOT BUBBLE CHAMBER. Design Report. Marston, P. G. (comp.) (Argonne National Lab., Ill.). Jun 1968. 154p. Dep. NTIS.

The comprehensive design report for the superconducting magnet system is presented. Sections are devoted to magnet system description, superconducting coil system, refrigerator and cooling, energizing system, iron, and safety. The system is designed to generate a uniform magnetic field of 18 kG in a volume approximately 15 ft in diameter and 10 ft high. This represents approximately 8×10^7 J of stored energy. The superconducting energizing coils are wound from fully stabilized (copper) niobium titanium and operate in a bath of liquid helium at a temperature of approximately 4.5°K (1.25 atmospheres). Sixteen hundred tons of low-carbon steel castings form a full flux return path. A helium refrigerator simultaneously provides 400 W of closed-cycle cooling at 4.5°K, 500 W at 70°K, and produces 25 liters of liquid helium per hour. The 30-kW power supply (3000 A at 10 V dc) brings the system to full field (2200 A) in approximately two and one-half hours. The safety, reliability, and installation cost of the superconducting system are considered to be equivalent to those of a conventional system. The operational power cost saving (from superconductivity) is estimated at $400,000 per year. The total installed magnet system cost is about $3,000,000. Appendixes include a comparison of superconducting and conventional energizing coil systems and testing of the 12-ft HBC magnet. (108 figures, 2 tables) (R.W.R.)

48126 (COO–3065-12) COUNTER EXPERIMENTS. Melissinos, A. C. (Rochester Univ., N. Y. Dept. of Physics and Astronomy). 1 May 1972. 26p. (CONF-720409–8). Dep. NTIS.

From third international conference on experimental meson spectroscopy; Philadelphia, PA. (28 Apr 1972).

Technical aspects of wide-aperture magnetic spectrometers are discussed. The "Omega" project at CERN, the M.P.S. and "Argo" systems at BNL, and the large streamer chambers at SLAC and Argonne are described. Lead-loaded glass detectors and the use of solid-state counters are also considered. (14 figures, 4 tables) (R.W.R.)

48127 (FRNC-TH–195) STUDY AND CONSTRUCTION OF A CHERENKOV DETECTOR FOR A BREMSSTRAHLUNG EXPERIMENT. Willis, Nicole (Paris Univ., Orsay (France)). 1972. 56p. (In French). Dep. NTIS (U. S. Sales Only).

Thesis.

A Cherenkov detector was constructed for a bremsstrahlung experiment: $p + p \rightarrow p + p + \gamma$ (γ of 50 MeV). The performance of the detector was controlled by a 2 nanoampere proton beam with stochastic extraction. The measured occupation time was 20%, and the threshold was fixed to give the counter an efficiency of 74%; a background of 800 low energy γ pulses/second was counted. The following results were obtained: 4 proton–proton coincidences/second were obtained with the γ channel disconnected; and 10 pulses/hour were observed in $p-p\gamma$ coincidence with the γ channel connected. Differential cross sections are given. (France)

48128 (FRNC-TH-209) IDENTIFICATION OF PARTICLES USING CHERENKOV COUNTERS IN AN EXPERIMENT ON THE POLARIZATION IN BACKWARD $\pi^\pm$P ELASTIC SCATTERING. Aoi, Hideki (Paris Univ., Orsay (France)). 1972. 41p. (In French). Dep. NTIS (U. S. Sales Only).

Thesis.

The use of Cherenkov counters in the measurement of the polarization parameter of elastic $\pi^\pm + p$ backward scattering was investigated. A Monte–Carlo program was developed in order to determine the geometrical parameters of a gas counter and a total reflection Plexiglas counter. This program enabled the quantity of Cherenkov radiation collected to be estimated in terms of the dimensions of the optical system. A gas counter (C4) and a total reflection counter (C7) were constructed. Measurements of the efficiency and forward rejection rates (insensitivity to backscattered protons) yielded the following values: 99% and 96% for C4 and 95% and 98% for C7. This counter system can be used in conjunction with kinematic tests to study the polarization up to $W = 0.8$ (GeV/c)^2 in spite of the large amount of background noise. The results obtained in the backward $\pi^\pm$ elastic scattering in the 6 GeV/c region (cross sections, polarization) are presented. (France)

48129 (JINR–P13-6406) MEASUREMENT OF ENERGIES OF GAMMA QUANTA AND ELECTRONS IN BUBBLE CHAMBERS. Strugal'skii, Z. S. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of High Energy). 1972. 20p. (In Russian). Dep. NTIS (U. S. Sales Only).

A description of a systematic analysis of the gamma-quantum energy determination methods using bubble chambers of different dimensions and with different fillings is presented. (8 figures, 1 table) (auth)

48130 SUPERCONDUCTING MAGNET COILS FOR THE OMEGA SPARK CHAMBER AT CERN. Schleich, A. Brown Boveri Rev.; No. 2-3, 78-87(1972).

Superconducting windings of zero electrical resistance are being carried over from the development stage into industrial application. Brown Boveri are building the superconducting d.c. excitation system for the "Omega" spark chamber magnet which will be used for nuclear physics research at CERN. The magnet will weigh 1300 t and its excitation coils will have an overall diameter of 5 m. Magnet, coils and type of conductor are described. Special requirements and design features of the electrical insulation, thermal insulation, and mechanical support system for the windings operating under high vacuum at −269°C are discussed. (auth)

48131 75-cm HYDROGEN BUBBLE CHAMBER. Hirabayashi, Hiromi; Kita, Isao; Tateno, Hiroto; Yoshimura, Yoshio (Tokyo Univ. Tokyo Univ. of Agriculture and Tech.). Jap. J. Appl. Phys.; 11: No. 8, 1187-91(Aug 1972).

A 75 cm hydrogen bubble chamber with 220 liters of liquid and its refrigerator were constructed. In the latest run the chamber was successfully operated and the tracks of cosmic rays and Compton electrons from cobalt-60 gamma rays were seen and photographed. This chamber has several grand features for the improved characteristics of operation and precision photography of tracks. Some of those essential features and the results of the operations are reported. (auth)

48132 AUTOMATED ANALYSIS OF CLOUD CHAMBER TRACKS. Smith, D. E. (Univ. of California, Livermore); Finn, H. F.; Baltz, D. W. Rev. Sci. Instrum.; 43: No. 9, 1239-43(Sep 1972).

Automated methods have been developed for counting individual droplets along diffuse cloud chamber tracks. A programmable film reader measures film density in two dimensions. Computer programs analyze this density map to obtain droplet counts. Droplets with diameters of 15 μ and density contrast of 0.5 have been successfully identified, measured, and counted. Real space track dimensions are obtained by making track measurements on both views of stereo camera pair. Reproducibility of droplet counts is ±3% and accuracy is ~8%. (auth)

48133 SPATIAL SPARK JITTER MEASUREMENTS OF HIGHLY CHARGED NUCLEI FOR OPTICAL SPARK CHAMBERS. Smoot, G. F.; Buffington, A.; Smith, L. H. (Univ. of California, Berkeley). Rev. Sci. Instrum.; 43: No. 9, 1285-6(Sep 1972).

The spatial jitter of sparks about the paths of relativistic nuclei of various charges z has been measured for optical spark chambers. For normal incidence the jitter measured was consistent with the 1/z dependence expected from diffusion of the ionization electrons. (auth)

48134 PARTICLE LOCATION ALONG THE LENGTH OF A NEON FLASH-TUBE. Ayre, C. A.; Thompson, M. G.; Whalley, M. R.; Young, E. C. M. (Univ. of Durham, Eng.). Nucl. Instrum. Methods; 103: No. 1, 49-52(1972).

Measurements have been made of the time delay in arrival and the amplitude of the digitization pulses from both high and low pressure neon flash-tubes. The velocity of propagation of the digitization pulse is 3.6×10^6 m s^{-1} for the low pressure tubes and 6.7×10^6 m s^{-1} for the smaller high pressure tubes. A qualitative explanation of the delay time is given. The results show that it could be possible to locate the initiating particle of the flash tube along the axis of the tube by timing techniques to approximately ±10 cm. (auth)

48135 SATELLITE EXPERIMENT TO MEASURE THE INTENSITY AND ENERGY SPECTRUM OF GAMMA RAYS FROM SOLAR FLARES IN THE RANGE 50 TO 500 MeV. Bignami, G. F.; Bland, C. J.; Citterio, O.; Dean, A. J.; Inzani, P. (CNR, Milan). Nucl. Instrum. Methods; 103: No. 1, 149-56(1972).

A high energy solar gamma-ray telescope incorporating a lenticular Cherenkov for directional measurement and an energy calorimeter is described. The instrument is included in the payload of TD-1 ESRO spacecraft to be launched into a sun-pointing orbit during spring 1972. The results of laboratory and accelerator tests are presented and the sensitivity and measurement capability to solar flare gamma rays is discussed. (auth)

Radiometric Instruments

Refer also to abstract 48221.

48136 RADIATION MEASUREMENT SYSTEM WITH AUTOMATIC STANDARDIZATION USING A RATE FEEDBACK SIGNAL. Shah, Franklin Bong-see; Troutman, Paul Henry (to Industrial Nucleonics Corp.). U. S. Patent 3,668,401. 6 Jun 1972. Filed 11 Mar 1970.

A radiation measurement system for measuring an absorption-dependent property of a material is employed in a digital process control system. The radiation measurement system includes an automatic standardization system for performing zero and source standardization and a detector for detecting the completion of each standardization mode. A rate feedback signal is derived in each standardization mode to damp the standardizing operation. The system was designed specifically for continuously measuring the basis weight in a paper manufacturing process using beta particles. (auth)

48137 GAUGE USING ENVIRONMENT-INSENSITIVE RADIATION BEAM CROSS-SECTION LIMITER. Cahill, Bonaventure B.; Lyon, Wilfred W. (to Ohmart Corp.). U. S. Patent 3,668,399. 6 Jun 1972. Filed 30 Jun 1969.

A gage for measuring the characteristics of a specimen is described including a shielded source of radiation, a detector spaced from said source, a radiation beam cross-section limiter through which radiation from the source passes as it travels along a path for impingement upon the specimen which is located in a gap between the limiter and the source for selectively blocking and unblocking radiation from the source. The radiation beam cross-section limiter includes a bore sealed at both ends through which the radiation from the source passes in its path to the specimen and detector. By virtue of the sealed beam-limiting bore the mass of material contained within the bore, which usually is air, remains constant independent of changes in the environment, such as changes in environmental temperature, barometric pressure, humidity and the composition of the surrounding gas, thereby substantially reducing errors in the gaging process introduced by such environmental changes. (1 figure) (auth)

48138 USE OF NUCLEAR INSTRUMENTS IN THE HUNGARIAN HEAVY INDUSTRIES. Rozsa, S. (MTA Izotop Intezete, Budapest). Izotoptechnika; 15: No. 2, 67-70(Feb 1972). (In Hungarian).

The application of nuclear instruments in mining, power stations, and in the petroleum, chemical and aluminum industry is briefly discussed. (auth)

48139 VENTILATION OF ELECTRON CAPTURE DETECTORS. Karamian, N. A. (Dept. of Health, Education, and Welfare, Rockville, Md.). Health Phys.; 23: No. 2, 257(Aug 1972).

Gas chromatographs using electron capture detectors are equipped with radioactive foils which must be handled with caution to reduce personnel exposure to a minimum. The release of radioactive material from tritium, radium, ^{90}Sr, and ^{63}Ni foils is discussed. The use of a special hood, to overcome this hazard, placed on top of the electron capture detector, to vent the radioactive air contaminants from the unit and the working area, is described. (UK)

Radiation Effects on Instrument Components, Instruments, and Electronic Systems

Refer also to abstract 49692.

48140 IONIZING-RADIATION-PRODUCED NONVOLATILE METAL-OXIDE-SEMICONDUCTOR (MOS) MEMORY. Ferber, R. R. (Westinghouse Electric Corp., East Pittsburgh). pp 9-16 of Record of the 11th Symposium on Electron, Ion, and Laser Beam Technology. /Thornley, R. F. M. (ed.). New York; Inst. of Electrical and Electronics Engineers, Inc. (1971).

From eleventh symposium on electron, ion, and laser beam technology; Boulder, Colo. (12 May 1971).

A technique of "burning in" a preferred state in metal-oxide-semiconductor (MOS) memory cells by using ionizing radiation (electron bombardment, for example) was demonstrated. When the power is removed and reapplied, the memory always configures itself to the preset pattern while still allowing normal electrical alteration of stored information in either random access memory (RAM) or shift register configuration memory chips. In some respects, this technique yields results similar to those of the "read MOSTLY memory" technique developed recently. Potential applications of this data "burn in" technique are as an additional or improved method of fabrication of read-only semiconductor memories (ROM) and reprogrammable read-only memories. Considerable application also exists for a memory which can be preprogrammed to turn on in a particular memory pattern each time power is interrupted and reapplied, and still operate as an ordinary electrically alterable memory. A conceptual reprogrammable electron beam-scanned MOS memory array tube which uses this ionizing-radiation-induced predisposition is described as a memory design example. (6 figures, 1 table) (auth)

48141 ONE MeV ELECTRON IRRADIATION OF NEW TECHNOLOGY SILICON SOLAR CELLS. Curtin, D. J.; Meulenberg, A. (Communications Satellite Corp., Clarksburg, W. Va.). Energy Convers.; 12: No. 3, 81-4(Sep 1972).

Silicon solar cells were irradiated with 1-MeV electrons using a Van de Graaff accelerator. Covered cells with TiO_x antireflective coatings had higher electrical performance before and after irradiation than cells from the same ingot covered with SiO antireflective coatings. High-efficiency experimental ρ-on-n and n-on-ρ cells were tested and compared to standard cells of the same types. The initial degradation rate of the high-efficiency n-on-ρ cells was greater than that of the standard cells, but the efficiency—fluence curves for both groups merged after exposure to 3×10^{14} (1 MeV) electrons/cm^2. In the case of the ρ-on-n cells, merging of the curves did not occur even at a fluence of 10^{16} electrons/cm^2. (auth)

Miscellaneous Instruments and Components

Refer also to abstracts 47968, 48405, 49316, 49810, 49845, 49963, 49964, and 49992.

48142 (CEA-R–4320) SYSTEM OF PROGRAMS FOR AN INTERACTIVE GRAPHIC DISPLAY UNIT USED IN CONJUNCTION WITH A CII 10 020 COMPUTER. Morvan, Pierre (Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires). Mar 1972. 194p. (In French). Dep. NTIS (U. S. Sales Only).

Thesis. Submitted to Paris Univ. (France). Faculte des Sciences.

The various different display techniques are reviewed. The problem of graphic programming for nuclear physics applications is discussed. The display unit studied by the CEA is presented from the points of view of the different ways in which it can operate and the various means available for dialogue with the operator. The assembly of structured programs enabling the unit to be integrated into a real-time system is described. The extensive exploitation of this display unit has led experimenters to suggest the improvements and modifications which are presented in the conclusion. (83 figures, 13 photographs) (France)

48143 (DUN-SA–185) BASIC AS A PROCESS CONTROL AND MONITORING COMPUTER LANGUAGE. Worster, L. D. (Douglas United Nuclear, Inc., Richland, Wash.). [nd]. 7p. Dep. NTIS.

The computer programming language BASIC is briefly described, and a short summary of BASIC statements is given. BASIC has been shown to offer an optimum combination of simplicity and computational power for process control and monitoring in the applications of a computerized test system to the performance evaluation of critical nuclear reactor systems. (W.H.K.)

48144 (EGG–1183-5015) RECENT DEVELOPMENTS IN COLOR-FILM THREE-BAND SPECTROSCOPY. Technical Paper EGG-LAD-126. Evans, S. A. (EG and G, Inc., Los Alamos, N. Mex.). Apr 1972. Contract AT(29-1)-1183. 26p. Dep. NTIS.

The "effective exposure" (EFFEXP) method can be used to study the optical properties of artificial auroras and other high-altitude effects that accompany high-altitude nuclear bursts. Color film records are particularly useful since they yield both radiance and spectral data when properly unfolded. The main features of the EFFEXP method are explained by using black and white film, and these results are then generalized to include color film. The problem of determining the dye concentration of each layer of color film is considered, and a technique for doing this is presented. A method for using color film as a low-resolution spectrograph is given. Finally, examples are presented demonstrating the usefulness of color film as a quantitative optical radiation detector. (6 figures, 1 table) (R.W.R.)

48145 (KFK–1467) CAMAC 50-MHz SCALER MODULE TYPE LEM-52/1.6. SPECIFICATION AND DESCRIPTION. Borcherding, K.; Gruber, P.; Ottes, J.; Tradowsky, K. (Kernforschungszentrum, Karlsruhe (West Germany). Labor fuer Elektronik und Messtechnik). Mar 1972. 37p. (In German). Dep. NTIS (U. S. Sales Only).

The scaler described is equipped with a 24-bit preset scale register which can be reduced to 18, 16 or 12 bits and allows reading even during the gate time. The state of the scaler including the LAM source is represented in the status register which permits reading all over the time but postulates reading in the case of the scaler's LAM (Look-at-Me) caused by an overflow. Setting of the operating mode is done with the control register. The overflow signal preselected with the flip-flop Select Channel is to be connected due to the requirements either to the patch lead P1 or to the jack Overflow in the front panel. This enables the scaler to be used as an interval time preset scaler if cabled with the CAMAC Timer type LEM-52/2.6. TTL or NIM level signals can trigger the input Signal and the dead time is defined with 20 ns. The level of triggering the input Inhibit must be TTL. In addition to this the input Signal can be gated with NIM level signals at the input Gate enabled or disabled by the control register. A lamp indicates the state of the LSB. (auth)

48146 (N–72–19861) 100,000 PULSE-HEIGHT ANALYZER FOR USE IN HIGH-ENERGY COSMIC-RAY EXPERIMENTS (HECRE) ON HIGH-ALTITUDE BALLOON FLIGHTS. Cancro, Ciro A.; Garrahan, Norman M.; McGowan, Richard G. (National Aeronautics and Space Administration, Greenbelt, Md. Goddard Space Flight Center). Dec 1971. 24p. (NASA-TM-X–65836; X–711–71–500). NTIS.

A description is given of a wide dynamic range pulse height analyzer system developed for use on High Energy Cosmic Ray Experiment (HECRE) Balloon Flights. A wide dynamic range of 100,000 is obtained by extending the range of a basic 1024 channel analyzer through the use of multiple ranges and range selection. The system described contains four 100,000 pulse height analyzers. Each 100,000 pulse height analyzer consists of a group of cordwood welded modules mounted and interconnected on a printed circuit card. Four of these card assemblies, the required clock drive circuitry (discrete components mounted and interconnected on a separate card) and three input-output connectors are interconnected and mounted on the system board. (auth) (STAR)

48147 (NP–19392) BIENNIAL REPORT, 1969–71. (National Standards Lab., Sydney (Australia). Div. of Applied Physics. National Standards Lab., Sydney (Australia). Div. of Physics). 1971. 92p. Dep. NTIS (U. S. Sales Only).

Maintenance of standards of measurement in the fields of thermometry, photometry and radiometry, viscometry and hygometry as well as the standards of length, mass, time interval and associated quantities, electrical quantities and optical quantities is described. Development and progress in research in solar physics, molecular physics, airglow and aurora, and theoretical astrophysics are reviewed. (Australia)

48148 (SC-DC–721065) THERMOCOUPLE TEMPERATURE/-CIRCUIT-POSITION DIAGRAM, A TOOL FOR THERMOELECTRIC CIRCUIT ANALYSIS. Reed, R. P. (Sandia Labs., Albuquerque, N. Mex.). Jun 1972. 19p. (CONF-720332–1). Dep. NTIS.

From Underground nuclear test measurements symposium II; Palo Alto, CA. (21 Mar 1972).

An approach to thermocouple circuit analysis based on a reformulation of the laws of thermoelectric thermometry and on the use of temperature/circuit-position diagram as a tool of visualization is described. These tools can improve and simplify the planning of experiments to avoid spurious emf contributions from unrecognized source elements. They clearly reveal the problems that are particularly important in the thermocouple measurement of transient temperatures with complex circuits in the radiation environment and provide the means to design reliable experiments. The example, given solely to illustrate the method, is a conservative one. The errors described are not unusual; they are, in fact, much smaller than real errors experienced from these causes by many experimenters in practical application. (4 figures) (auth)

48149 (UCRL-Trans–10624) HOLLOW SPHERE CALORIMETER FOR ENERGY MEASUREMENTS OF PULSED HIGH POWER LASERS. Buechl, K.; Pfeiffer, H. J. Translated for Univ. of California Lawrence Livermore Lab., Livermore, from Z. Angew. Phys.; 32: No. 5-6, 359-62(1972). 14p. Dep. NTIS.

The hollow sphere calorimeter is a type of calorimeter which functions from ultraviolet to points far past infrared, independently of wavelength. The radiation is completely absorbed by the interior of a hollow sphere, whose heat increase is measured. A high load (and therefore the suitability for pulsed high-power lasers) is achieved by having a sufficiently large interior surface. However, in order to have a good degree of sensitivity at the same time, the wall of the hollow sphere must be as thin as possible. This can be done if the sphere is constructed by a special process. The laser radiation is focussed by a lens into an opening of about 2 mm diameter in the sphere. In order to avoid a breakthrough of gas in the focus of the lens, the hollow sphere is placed in a vacuum chamber ($\leq 10^{-1}$ torr). This also provides an excellent insulation against brief temperature fluctuations at the place of measurement. (6 figures) (R.W.R.)

48150 (Y–1837) COMPUTER-ASSISTED OPERATION OF AN ELECTRONIC MAINTENANCE TEST SYSTEM. McMillan, D. E. (Union Carbide Corp., Oak Ridge, Tenn. Y-12 Plant). 10 Jul 1972. Contract W-7405-eng-26. 104p. Dep. NTIS.

The application of a small digital computer to improve the operation of an automatic test system was investigated. The test system had been designed for production testing of digital electronic circuitry, but it was being used for diagnostic testing in maintenance of electronic equipment. The objectives of using a computer as a control element were improved communication between the test system and its operator and a reduction in the number of system tests required for diagnostic testing. Interface circuits and operating programs were designed and built, and the test system was operated under computer control to study the practicality of improving the performance of the test system. The test system proved easier to operate when the computer teletype was used as a communication device, and a reduction of 30 percent or more in the number of tests was achieved. Unexpectedly large amounts of computer memory were required to support the teletype communications system, and it was discovered that a careful balance must be made between message clarity and length. Interface hardware was most effective when it had the simplest form; and it was concluded that, whenever a choice is possible, software rather than hardware should be used to implement a control function. (18 figures, 5 tables) (auth)

48151 MULTIPLE-FOCUSING TIME-OF-FLIGHT MASS SPECTROMETERS. PART II. TOFMS WITH EQUAL ENERGY ACCELERATION. Poschenrieder, W. P. (Max-Planck-Institut fuer Plasmaphysik, Garching, Ger.). J. Mass Spectrom. Ion Phys.; 9: No. 4, 357-73(Sep 1972).

The theory of multiple-focusing time-of-flight mass spectrometers with equal momentum acceleration and magnetic fields presented in Part I is extended to time-of-flight mass spectrometers with equal energy acceleration. Here, directional focusing and vanishing energy-dependent dispersion in time-of-flight and imaging are obtained by combining linear drift spaces with electric sector fields. A full account of the first-order theory is given together with special geometries which provide stigmatic imaging. The capabilities and limitations of these instruments are discussed by means of a numerical example. The main problem still rests within the ion source, but for special applications such as a sputtering ion microprobe these new mass spectrometers appear particularly suited. (auth)

48152 PULSE COUNTING APPARATUS FOR PARTICLE BEAM. 2. Nose, Naoki; Kodera, Kumasaburo; Makita, Tsutomu (Kyoto Univ.). Shitsuryo Bunseki; 20: No. 1, 23-33(Mar 1972). (In Japanese).

Design factors of the ratemeter and reversible decade counter for pulse counting apparatus are discussed. The resolving time of the ratemeter is adjustable for 0.4 μs and 40 μs. Counting accuracy is within 1% on all ranges at a duty factor up to 90%. The resolving time of the decade counter is about 30 ns, its gate time is selective from 0.01 s to 315 s, and its output codes are fed to D–A converter. In addition, this decade counter has a subtract gate for synchronous counting. The overall pulse counting apparatus was tested by means of both square pulses and photomultiplier output pulses, and the results are satisfactory for particle counting. (auth)

48153 SUPPRESSION OF HETERONUCLEAR SPIN–SPIN INTERACTION IN NUCLEAR MAGNETIC RESONANCE SPECTRA BY MEANS OF A SWEEP GENERATOR. Gavrilov, Yu. D.; Bystrov, V. F. (Inst. of Chemistry of Natural Compounds, Moscow). Instrum. Exp. Tech. (USSR) (Engl. Transl.); 14: No. 5, 1425-7 (1971).

Translated from Prib. Tekh. Eksp.; 14: No. 5, 140-1(1971).

An efficient total-double-resonance method is described for suppressing spin–spin interaction with D^2 nuclei in nuclear magnetic resonance spectra. The principle of operation of the network consists in frequency modulation of the irradiation frequency, which allows a substantial reduction of the generator output power. (4 figures) (auth)

48154 MINIATURIZED MICROCALORIMETER. Barberi, Paul (CEN de Saclay, Gif-sur-Yvette, France). Rev. Gen. Therm.; 11: No. 124, 303-5(Apr 1972). (In French).

A differential calorimeter was developed having a remarkable resistance to fluorinating agents (e.g., UF_6). Its extreme miniaturization greatly facilitates its use. (France)

48155 STABILIZER OF THE CURRENT WHICH HEATS THE TAPES OF AN ION SOURCE IN A MASS-SPECTROMETER. Samsonov, S. P.; Gorokhov, I. M. (Inst. of Precambrian Geology and Geochronology, Leningrad). Instrum. Exp. Tech. (USSR) Engl. Transl.); 14: No. 5, 1440-2(1971).

Translated from Prib. Tekh. Eksp.; 14: No. 5, 151-3(1971).

The circuit of a transistorized current stabilizer for supplying the tapes of the ion source in a mass spectrometer having surface ionization is described. A self-excited controlled amplifier (s.a.) having a high gain and a low null drift is used in the stabilizer as the feedback amplifier. The circuit ensures a smooth control of the current in the 0.2 to 5 A range. For a simultaneous variation of the line voltage by ±10% and the load resistance from 0 to 3.5 Ω, the relative current instability does not exceed 0.002%. (2 figures) (auth)

48156 SELF-COMPENSATING MAGNETOMETER WITH A SUPERCONDUCTING SOLENOID. Sokolov, V. I. (Moscow State Univ.). Instrum. Exp. Tech. (USSR) (Engl. Transl.); 14: No. 5, 1506-8(1971).

Translated from Prib. Tekh. Eksp.; 14: No. 5, 206-8(1971).

A magnetometer having a vibrating sample for measurement of magnetic characteristics in the interval 2 to 80°K and magnetic fields of up to 63 kOe is described. The sensitivity of the instrument is 1.2×10^{-3} G-cm^3, and the relative accuracy is ~1.5%. (2 figures) (auth)

48157 COMPENSATORS OF THE MAGNETIC FIELD NON-UNIFORMITY OF A SUPERCONDUCTING SOLENOID. Nazarov, V. B.; Zabrodin, V. A.; Krainskii, I. S.; Gal'perin, L. N. (Inst. of Chemical Physics, Moscow). Instrum. Exp. Tech. (USSR) (Engl. Transl.); 14: No. 5, 1509-11(1971).

Translated from Prib. Tekh. Eksp.; 14: No. 5, 208-10(1971).

Compensators for the magnetic field nonuniformity of a superconducting solenoid used in a nuclear magnetic resonance spectrometer are described. The compensators, which are placed in the thermal aperture of the solenoid, allow independent control of the gradients $\partial H_{0z}/\partial z$, $\partial^2 H_{0z}/\partial z^2$, $\partial^3 H_{0z}/\partial z^3$, $\partial H_{0z}/\partial x$, $\partial H_{0z}/\partial y$, $\partial^2 H_{0z}/\partial z dx$, and $\partial^2 H_{0z}/\partial z dy$, and are comparatively simple to fabricate. (2 figures) (auth)

48158 E x B MASS SEPARATOR DESIGN. Seliger, R. L. (Hughes Research Labs., Malibu, Calif.). pp 183-92 of Record of the 11th Symposium on Electron, Ion, and Laser Beam Technology. /Thornley, R. F. M. (ed.). New York; Inst. of Electrical and Electronics Engineers, Inc. (1971).

From eleventh symposium on electron, ion, and laser beam technology; Boulder, Colo. (12 May 1971).

The equations of motion are developed and solved for ion trajectories inside an E × B-type mass separator. Curves are presented which illustrate the focusing of the undeflected ion beam, the trajectories along which ions of different mass species disperse inside the separator channel, and the exit slopes of mass species leaving the separator, as functions of a separator strength parameter. For strong separators, beam focusing is significant and is shown to be nonaxisymmetric when the electric and magnetic fields are uniform and orthogonal. A method of correcting the astigmatism by tilting the magnetic polepieces is presented. (6 figures) (auth)

48159 ION IMPLANTATION SYSTEM FOR DEVICE PRODUCTION. Wilson, R. G.; Shifrin, G. A. (Hughes Research Labs., Malibu, Calif.). pp 351-8 of Record of the 11th Symposium on Electron, Ion, and Laser Beam Technology. /Thornley, R. F. M. (ed.). New York- Inst. of Electrical and Electronics Engineers, Inc. (1971).

From eleventh symposium on electron, ion, and laser beam technology; Boulder, Colo. (12 May 1971).

A device and circuit production implantation system was placed in operation in a MOS integrated circuit manufacturing environment. This system was developed to convert the process of ion implantation doping of MOSFET devices and integrated circuits from a proved laboratory technique to a reliable and economical manufacturing process. The system was designed with consideration for reliability, safety, ease of maintenance, and economy of manufacturing processes. A target chamber was developed which allows a variable number of various sized wafers (e.g., 45 2-in. wafers) to be implanted in each pumpdown. The target chamber and beam transport and handling system were designed to be compatible, to have a short vacuum cycle time, and to be operated easily by a production worker at a rate of more than 200 2-in. wafers per day (at a dose of 10^{14} ions/cm^2). The vacuum pumpdown and implantation cycle is largely under automatic control. Manufacturing techniques are being developed to be compatible with present planar MOS technology. The ion energy can be varied from 20 to 120 keV (boron or phosphorus, etc.). The dose range capability is 2.5×10^{11} to 2×10^{15}/cm^2. Boron current to the target can be varied from about 0.1 to 20 μA and can be rastered (scanned) uniformly over an area 10×10 cm^2. The pressure during implantation is less than 2×10^{-6} torr, and pumpdown between sample batches is less than 10 min. (4 figures, 1 table) (auth)

48160 SIMPLE MODIFICATION OF A COMMERCIAL MASS SPECTROMETER FOR METASTABLE DATA COLLECTION. Wachs, Timothy; Bente III, Paul F.; McLafferty, F. W. (Cornell Univ., Ithaca, N. Y.). J. Mass Spectrom. Ion Phys.; 9: No. 3, 333-41(Aug 1972).

The geometry of a Hitachi Perkin–Elmer RMU-7 double-focusing mass spectrometer was reversed by interchanging the positions of ion source and electron multiplier. The high metastable resolution of the modified instrument (150 for narrow peaks) resulted in 57 new transitions found for n-decane. Because of the mode of operation, reproducible peak shapes and intensities can be obtained. (5 figures, 2 tables) (auth)

48161 MICROCALORIMETER–BALANCE FOR THE STUDY OF SOLID–GAS REACTIONS IN FLUORINE CHEMISTRY. Paillet, A. (CEN de Saclay, Gif-sur-Yvette, France). Rev. Gen. Therm.; 11: No. 124, 307-9(Apr 1972). (In French).

A device enabling the simultaneous measurement of variations in weight and heat flux (a MacBain balance combined with a Barbeir microcalorimeter) is described. Studies of complexes between UF_6 and alkali fluorides are cited as examples. (France)

48162 INSTRUMENT FUNCTION OF A CYLINDRICAL ELECTRON ENERGY ANALYZER. Aksela, Seppo (Univ. of Oulu, Finland). Rev. Sci. Instrum.; 43: No. 9, 1350-6(Sep 1972).

The instrument function describing the broadening of the spectral lines due to the energy analyzer is treated as the convolution product of the calculated partial energy distributions arising from the angular divergence, the widths of the slits, and the nonradial motion of the electrons. The cases of first order focusing, second order focusing, and minimum trace width are considered. The nonradial motion of electrons in the electric field caused by emission from outside the symmetry axis is calculated numerically without making approximations in the analytical expressions. The analysis leads to results different from those published earlier. The calculations show that combinations of electron optical parameters can be found for which the effect of nonradial motion is very small. When these combinations of parameters are used, the electron source can be made comparatively large in the transverse direction. (auth)

48163 SIMPLE, LOW POWER, MULTIPLE PULSE NMR SPECTROMETER. Vaughan, R. W.; Elleman, D. D.; Stacy, L. M.; Rhim, W.-K.; Lee, J. W. (California Inst. of Tech., Pasadena. Jet Propulsion Lab., Pasadena, Calif.). Rev. Sci. Instrum.; 43: No. 9, 1356-64(Sep 1972).

A low power (100 W) pulse spectrometer is described for work in solids, and the use of the spectrometer for performing the Waugh "line narrowing" multiple pulse experiments is demonstrated and discussed in detail. The performance of these measurements with a low power spectrometer is made possible by controlling the nature of the transient responses of tuned circuits within the spectrometer, and means for nullifying the effects of such transients on the effective rotation axis of an rf pulse are presented. (auth)

48164 SUPERCONDUCTING SOLENOID FIELD MONITORING WITH ^{133}Cs NMR. Dickson, Edward M. (Cornell Univ., Ithaca, N. Y.). Rev. Sci. Instrum.; 43: No. 9, 1381-2(Sep 1972).

Magnetic field monitoring in superconducting solenoids using ^{133}Cs NMR is suggested, and fabrication of samples that withstand repeated thermal cycling is described. (auth)

48165 RADIATION EXPOSURE MEASUREMENTS IN THE 8 TO 15 kVp X-RAY RANGE. Jacobson, A.; Banks, T. E. (Louisville Univ., Ky.). Health Phys.; 23: No. 2, 143-7(Aug 1972).

Exposure measurements are described for a typical Grenz-ray machine operating in the 8 to 15 kVp energy range. The previously acknowledged energy dependence and sensitivity limitation of available instrumentation compromised the precision of such exposure measurements. Thus, users of Grenz-ray machines, x-ray diffraction instruments, and other low-energy x-ray devices were often deluded into assuming the absence of ionizing radiations, as determined by use of conventional survey meters which were calibrated for higher energies. Although the first centimeter of tissue almost completely absorbs x-ray photons of this energy, their effects to such superficial sites as the lens of the eye are of concern. Commercially available detectors, of known energy dependence and sensitivity were used to measure primary and secondary levels of exposure to occupancy points. 10 mR/hr exposure rates were measured as far as 6 ft away from a scattering phantom irradiated by a 15 kVp primary beam. (auth) (UK)

48166 ELECTROLUMINESCENT FORM OF IMAGE STORAGE PANEL. Ranby, P. W.; Ellerbeck, R. P. (Thorn Lighting Ltd., Enfield, Eng.). Brit. J. Non-Destruct. Test.; 14: No. 4, 97-103(Jul 1972).

A description is given of an electroluminescent image storage panel (ISP) utilizing a ZnO layer. After irradiation, the panel is connected to a 240 V 50 Hz electricity supply and the X-ray image can be retained for 15 to 30 minutes. The image is green in color and has a maximum brightness of about 3 ft Lamberts. The image can be eradicated by heating the ISP to about 100°C for 20 sec. The ISP has a "speed" approximately equivalent to about one quarter the speed of Kodak Crystallex film, and a resolving power of 6 to 9 lines/mm. By using a higher frequency electrical supply, the brightness can be increased, but image quality deteriorates more rapidly. The ISP is compared favorably with fluoroscopy. (auth)

48167 ANALYSIS OF PULSE-RATE DEPENDENT NOISE AND COUNTING LOSSES IN ACTIVE PROCESSOR WITH FAST RECOVERY. Deighton, M. O. (Atomic Energy Research Establishment, Harwell, Eng.). Nucl. Instrum. Methods; 103: No. 1, 1-12(1972).

Non-stationary noise, which is an inherent property of most variable-parameter signal processing systems, is considered in relation to the low-noise pulse spectrometer in use at A.E.R.E. It is shown that, with random events, this leads to a significant increase in the noise at high counting rates. This can be counted by imposing a suitable protection time, but at some extra cost in counting losses. Detailed analysis of these shows that a compromise is possible, yielding overall performance figures much superior to most conventional pulse-shaping methods. (auth)

48168 OPTIMUM DESIGN OF A FOCUSSING ATOMIC-BEAM MAGNETIC RESONANCE APPARATUS. Olsmats, M. (Univ. of Uppsala); Wannberg, B.; Lindgren, I. Nucl. Instrum. Methods; 103: No. 1, 27-41(1972).

The principles of maximizing the transmission of a focusing atomic-beam magnetic resonance apparatus are considered. In the first part of the paper the design of multipole magnets in general is discussed. Numerical results are given for fourpole and sixpole magnets, showing the dependence of the magnetic field at the pole-tips on the shape of the pole-pieces and on the outer radius. In the second part of the paper the calculation of the transmission of focusing atomic-beam apparatuses with different combinations of two-, four- and sixpole magnets is described. The variation of the transmission with the lengths and the shape in the direction of the beam of the magnets as well as with other parameters is also investigated. Comparison between optimized apparatuses of various types shows that the transmission is mainly determined by the A-magnet, which should be a sixpole, while the B-magnet determines the size of the collector. A dipole B-magnet gives the smallest and a six-pole the largest collector area. Considering also the constructional problems, this leads to the choice of a sixpole-fourpole combination, which combines a high transmission with a fairly small collector area. (auth)

48169 NEW CIRCUIT FOR A DEAD TIME COMPENSATING TIMER. Bartosek, J. (Inst. of Applied Geophysics, Brno); Windels, G.; Hoste, J. Nucl. Instrum. Methods; 103: No. 1, 43-4 (1972).

A circuit for the dead time correction is described which eliminates errors due to the finite width of the timing pulse. (auth)

48170 AN INEXPENSIVE MULTISPECTRAL SCALING MODULE. Bowman, W. W. (Texas A and M Univ., College Station). Nucl. Instrum. Methods; 103: No. 1, 69-70(1972).

A NIM standard module is described which provides the binary timing words for memory routing necessary for multispectral scaling. The unit allows selection of time bases from 0.1 μs to 10^3 s for any number (1 through 63) of time channels. A circuit is included which ensures the tagging of the ADC address with the correct timing word even for time bases which are short compared to the ADC conversion time. (auth)

48171 DESIGN OF SHIFT REGISTER DELAYS FOR RANDOM ASYNCHRONOUS DATA INPUT. Porges, K. G.; Rudnick, S. J. (Argonne National Lab., Ill.). Nucl. Instrum. Methods; 103: No. 1, 157-65(1972).

The utilization of shift registers for purposes of providing fixed and stable delay in nuclear data processing is illustrated by two specific applications, one requiring delays of the order of seconds and the other requiring delays in the microsecond range. In the first case considered, the chief problem is to provide the capability of handling large random rates without undue digital dropout loss, in a device which does not require an excessive number of shift register bits. The solution proposed is a combination of cyclically operated parallel tracks with derandomizers. In the second case the required delay can be produced with a relatively modest number of bits, but the problem to be overcome is the limited time resolution of the device, determined by the minimum shifting period. This is shown to be amenable to improvement through a staggered shifting system which allows a subdivision of the shift period. (auth)

ISOTOPE AND RADIATION SOURCE TECHNOLOGY

Isotope Separation (Industrial)

Refer also to abstracts 47739, 47760, and 47768.

48172 (TRG-Report-2218) ZERO-DEFLECTION ISOTOPE SEPARATOR FOR THE STUDY OF ^{235}U FISSION PRODUCTS. MacLean, N. A. (Strathclyde Univ., Glasgow (Scotland)). 1972. 31p. Dep. NTIS (U. S. Sales Only). UK 50 pence.

Work carried out on the design and construction of an isotope separator of the Wien Filter type, and its application to the study of the fission products of ^{235}U, is described. Separated ion beams of some tens of microamps of stable elements are available at resolving powers in the region of 1000. Experiments showed the feasibility of investigating the decays of some short-lived fission products of ^{235}U separated in this machine, and work was done on the study of separated fission product and other radioactive isotopes. (auth)

48173 ISOTOPE SEPARATION APPARATUS. Nief, Guy; Morand, Jean-Pierre (to Commissariat a l'Energie Atomique). U. S. Patent 3,673,406. 27 Jun 1972. Filed 18 Jul 1969.

Apparatus is described for the photochemical separation of an isotope from a mixture of isotopes of an element, such as mercury, comprising at least one monoisotopic discharge lamp mounted in a fluid-tight chamber, an electrically conductive winding exciting the discharge lamp, means for circulating a liquid non-oxidizable and unreactive with the element through the chamber to continuously flush the walls of the chamber and the lamp, and an inlet and outlet in the chamber for introducing and exhausting a gaseous mixture containing the element and at least one substance which reacts with the isotope to be separated. (Official Gazette)

48174 METHOD FOR THE ISOTOPIC ENRICHMENT OF HYDROGEN. Lambert, Irma (to Commissariat a l'Energie Atomique). French Patent 2,079,707. 18 Oct 1971. Filed 10 Feb 1970. (In French).

A method for the isotopic enrichment of hydrogen, in view of heavy water production was developed which utilizes isotopic exchange between the hydrogen and a primary or secondary amine in the presence of a catalyst. The catalyst consists of an alkylamide of the alkaline metal corresponding to the primary or secondary amine. A diamine such as tetramethylethylenediamine was added to the system. (France)

Isotopic Power Sources

Refer also to abstracts 48319 and 48391.

48175 (CONF-710444-11) DEVELOPMENT OF THE RADIOISOTOPE POWER GENERATOR TRISTAN. Zahn, P. (Messerschmitt-Boelkow-Blohm G.m.b.H., Munich (West Germany)). 1971. 12p. Dep. NTIS (U. S. Sales Only).

From International conference on chemical sciences; Paris, France (20 Apr 1971).

Tristan is a program for the development of a radioisotope thermoelectric power generator sponsored by the German Government. The energy storage is provided by radioactive materials (^{90}Sr, in particular, is the most suitable heat source material). The thermoelectric power generator used is described and the physical properties of this type of generator are exposed. The performances obtained in a preliminary active test unit are given; applications of such power sources are presented. (France)

48176 (LA-4976) DATA SHEETS FOR PMC RADIOISOTOPIC FUEL. Keenan, T. K.; Kent, R. A.; Mulford, R. N. R. (Los Alamos Scientific Lab., N. Mex.). Jun 1972. Contract W-7405-eng-36. 8p. Dep. NTIS.

PMC is the acronym for Plutonia Molybdenum Cermet. Plutonia, PuO_2, forms the ceramic phase of the cermet and conditions ~80 atom % ^{238}Pu. Molybdenum is the metallic phase of the cermet. The thermal energy resulting from the radioactive decay of the ^{238}Pu isotope is converted into usable electrical power for space probe or other applications. The basic cermet module is a disk 2.145 in. dia and 0.212 in. thick. The ceramic phase is nominally 83 wt % with the molybdenum contributing the balance of the weight. Stacks of disks are encapsulated in suitable containers to form the working heat source. The characteristics of this cermet are listed with primary emphasis placed on proposed operational conditions and environments. LASL was responsible for the majority of the properties determinations and carried out some production support. Mound Laboratory, operated by the Monsanto Research Corp. (MRC), was responsible for the majority of disk production. Representative samples of cermet from both laboratories were used in many determinations. (auth)

48177 (NAA-SR-12181(Vol.1)) SNAP 2 MERCURY RANKINE PROGRAM REVIEW. Volume I. Final Summary Report. Wallerstedt, R. L.; McDonald, J. S.; Ellis, E. E. (eds.) (Atomics International, Canoga Park, Calif.). 15 Jun 1967. Contract AT(04-3)-701. 203p. Dep. NTIS.

A program extending over a period of ten years to develop a mercury-Rankine cycle power conversion subsystem for nuclear space power plants is reviewed. The program included work on combined rotating units, turbomachinery, components and systems, engineering analysis, and SNAP-2 flight test. (J.R.D.)

48178 (NAA-SR-Memo-7260(Del.)) SNAP POWER FOR HARDENED BASES. (Atomics International, Canoga Park, Calif.). 1962. Contract AT-11-1-GEN-8. 44p. Dep. NTIS.

Data and information are presented showing that SNAP power plants are available in a variety of power capabilities required for remote power stations. In the submegawatt range are the reliable, highly compact plants of the types developed for the space program. The combination of a simple rugged reactor, requiring practically no mechanical controls, with static thermoelectric power conversion will result in plants which are inherently reliable. Where megawatts or hundreds of kilowatts are required, the SNAP 8 or SNAP 4, coupled with conventional steam cycle equipment, could be available in the time it would take to construct the bases currently being programmed. For future bases, a 4- or 5-year program would yield tested, hermetically sealed plants which are automatic and self-regulating. Any of these plants would supply its design power for at least 1 year without refueling. (auth)

48179 HEART PACEMAKER USING A NEW ATOMIC BATTERY. Hori, Motokazu (Tokyo Women's Medical Coll.); Toyoshima, Eitoku; Toyama, Masatoshi; Kurosawa, Moriyoshi; Ohara, Yuichi. Igaku No Ayumi; 78: No. 1, 29-35(Jul 1971). (In Japanese).

A small,rate-fixed type heart pacemaker was manufactured, having a battery of ^{147}Pm as the energy source in direct generation system. ^{147}Pm battery contains five layers of a unit of PN layered surface of silicon semiconductor adhering closely with a base plate thinly coated with $^{147}Pm_2O_3$ so as to allow uniform irradiation of β-rays. The construction of this battery and working characteristics of the electronic circuit are shown by drawings. Pm has a half-life of 2.6 y and the dose of β-rays would naturally decrease by one half every 2.6 y. The current consumed by the electronic circuit in the present device was 15 μA on the average. By selecting the current of 120 μA, 8 times the current required, at the initial state, this pacemaker will have a life of 10 years. The seepage dose of the atomic battery is 6 mR/hr at zero distance. This pacemaker was used as a trial in a dog and its pacing was found to be effective. The pacings at the time of automatic heart beat and heart seizure are shown respectively by the wave form of arterial pressure and electrocardiogram. ^{147}Pm battery is a closed radiation source and has a good safety margin but it cannot be used indiscriminately in Japan because of legal restrictions. (Japan)

Radiation Sources

Refer also to abstract 49666.

48180 (ORNL-IIC-39) ENVIRONMENTS AND ISOTOPES. Raaen, Helen P. (Oak Ridge National Lab., Tenn.). Jul 1972. Contract W-7405-eng-26. 118p. Dep. NTIS.

The past significance and potential usefulness of isotopes (stable and radioactive; naturally occurring and man-made) to study, monitor, and control the environments, both terrestrial and extraterrestrial are discussed. Each of the geochemical realms of the terrestrial environment—atmosphere, hydrosphere, lithosphere, biosphere—is discussed separately. Examples show how isotopes are increasing the understanding of the properties, processes, and composition of each of these subsystems and how they are revealing the subtle interactions among them. The contributions of isotopes to man's successful invasion and continuing exploration of extraterrestrial environments are reviewed. They include space-environment simulation, life detection, life support, determination of environmental properties, and evaluation of effects that result from man's excursions into space. Twenty-four tables summarize the discussions, and 26 figures augment them; 870 references are cited. (auth)

48181 RADIOISOTOPE ENGINEERING. Eichholz, Geoffrey G. (ed.). New York; Marcel Dekker, Inc. (1972). 427p. $26.50.

A reference book is presented on the engineering aspects of using high-level radioisotope sources. Information is included on: radioisotope sources and their uses; large-scale production of radioisotopes; source encapsulation; design features of radiotherapy systems; design procedures for high-level radiation source configurations; optimization of irradiator systems; and a comparison of radioisotope and particle-accelerator sources for industrial irradiations. (L.C.L.)

Design and Fabrication

Refer also to abstracts 47966, 48246, and 49316.

48182 (NP-19313) NEUTRON SOURCE-ACTIVATION EQUIPMENT INELKY. Lindfors, B. (State Inst. for Technical Research, Otaniemi (Finland). Reactor Lab.). Feb 1972. 28p. (In Finnish). Dep. NTIS (U. S. Sales Only).

The construction of INELKY, as well as measurements and calculations made when constructing the activation unit are explained, especially those related to radiation protection. It is possible to use the unit for neutron activation, for neutron radiography, and for capture gamma studies. The operation and maintenance of the equipment are also described. (Finland)

48183 (ORNL-4529) LEAK TESTING ENCAPSULATED RADIOACTIVE SOURCES. Niemeyer, R. G. (Oak Ridge National Lab., Tenn.). Jul 1972. Contract W-7405-eng-26. 45p. Dep. NTIS.

The common methods used for leak testing radioactive sources are presented along with such factors as test reliability, sensitivity, and source design which affect the choice of the leak test to be used. Related data obtained from leak tests of experimental sources having known leak hole sizes are given. (auth)

48184 CYCLOTRON: SOURCE OF SHORT-LIVED RADIONUCLIDES AND POSITRON EMITTERS FOR MEDICINE. Laughlin, John S.; Tilbury, Roy S.; Dahl, J. Robert (Sloan-Kettering Inst. for Cancer Research, New York). Progr. At. Med.; 3: 39-62(1971).

Since certain radionuclides are either unique to cyclotron production or more advantageously prepared by positive-ion bombardment, cyclotrons are becoming an increasingly significant source of radionuclides of importance for both diagnosis and research. As many such radionuclides have rather short half-lives, relatively large radiation doses of the radionuclide can be administered. The cyclotron itself is first described, and then the appropriate means for producing a number of different radioisotopes, including ^{11}C, ^{13}N, ^{15}O, ^{18}F, ^{52}Fe, $^{67,68}Ga$, ^{68}Ge, ^{87}Sr, ^{87}Y, ^{111}In, and ^{123}I, are discussed. (12 figures, 2 tables, 43 references) (R.W.R.)

48185 PORTABLE NEUTRON SOURCE USING A PLURALITY OF MODERATING MEANS. Cason, John L. (to United States Atomic Energy Commission). U. S. Patent 3,659,106. 25 Apr 1972. Filed 21 Sep 1970.

A portable neutron source that uses the isotope ^{252}Cf as a source of neutrons is described. The isotope is mounted in a rotatable cylinder to permit the source to be "turned off". The thickness of the moderator for the neutron source can be varied to change the neutron spectrum. The neutron spectrum can also be varied by heating or cooling the moderator. (Official Gazette)

Industrial Uses

48186 EFFECT OF LOW-EXPOSURE GAMMA RADIATION ON THE POST-RIPENING, KEEPING QUALITIES, AND SOME COMPONENTS OF LEMONS. Szotyori, L. K.; Lindner, K.; Andrassy, E.; Hernandez, A. Elelmiszervizsgalati Kozlem.; 17: No. 3, 101-13(1971). (In Hungarian).

The ripening of citrus fruits is accelerated rather than retarded by radiation treatment. To attain favorable conditions of ripening radiation tests were carried out for slightly accelerating the ripening process while retarding fruit decay of lemons. The tests were conducted with 2.5, 10, 20 and 50 krad exposures with a ^{60}Co radiation source of 240 krad/hr capacity. During the 20-day storage period following radiation treatment the ripeness and the decay of fruits and a few changes in the amount of some components characteristic of fruit quality were examined at 5-day intervals. In the first days after irradiation the ascorbic acid content decreased, then markedly increased on the tenth day. Both of the higher exposures brought about a lesser increase. At the same time however the dehydroascorbic acid content increased 50 and 500% respectively. The increase of the citric acid content was greatly affected by radiation exposure immediately on the day of treatment causing an increase of nearly 100% at 50 krad exposure. At the end of the storage period the level of citric acid content was lower in general than that of untreated samples. The malonic acid content was almost unaffected by irradiation; it slowly decreased during storage. Increase of the sucrose content normally observed during storage was slightly promoted by irradiation. The quantities of most of the free amino acids did not change. However the amounts of alanine, glycine and serine decreased while the tyrosine content increased with the extent of exposure. Minimum decay was observed with 20 krad exposure when applied not later than two days after picking. (Hung. Tech. Abstr.)

48187 RADIOSTERILIZATION OF MEDICAL PRODUCTS. Oka, Mitsuru (Tokyo Metropolitan Isotope Research Center). Eisei Kagaku; 17: No. 2, 47-55(Mar 1971). (In Japanese).

Disposable medical products tend to be widely used all over the world, and plastics have increasingly been utilized for them. Radiosterilization is an effective sterilizing method for plastics. The D-value which is usually the D_{10} dose in the radiosterilization varies depending upon species of bacteria to be killed. Therefore, radioresistant bacteria having a high D-value should be adopted as the standard, in order to obtain a high safety rate in the radiosterilization. It seems to be suitable that spores of B. pumilus E 601 and cells of Str. faecium A_2-1 are used as this standard. On the other hand, the dose in the radiosterilization increases in proportion to number of bacteria attached to medical products. At present, the dose of 2.5 M rad is sufficient for radiosterilization. The influence of irradiation upon the quality and function of medical products is a disadvantage of radiosterilization. Some products made of polypropylene become fragile after the irradiation according to their material composition, and those made of teflon are unsuitable for the radiosterilization. Those made of polystyrene are generally suitable. Production of toxic substance by irradiating plastics has not been observed. A great advantage of radiosterilization is that sterilization can be made after products have been packed and sealed. (Japan)

48188 STORAGE BEHAVIOR OF IRRADIATED POTATOES. Penner, H. (Institut fuer Strahlentechnologie, Karlsruhe, Ger.). Ind. Obst- Gemueseverwert; 55: 58-61(1970). (In German).

The preservation of potatoes by irradiation is already permitted in Russia, Canada, the Netherlands, the United States and Israel, but it is still not of great economic importance. In the Federal Republic of Germany, extensive investigations are being carried out. For sprout inhibition, the potatoes are irradiated with doses of from 8 to 15 krads. The loss by shrinkage is likewise diminished, but also the healing of wounds. The irradiation caused significant damage of the surface of tubers, therefore no increased susceptibility against microorganisms is to be expected. A lay-out of a future irradiation device according to present knowledge is outlined. The advances of irradiation, as compared with the usual methods for sprout inhibition (storage at low temperatures and chemical treatment), are discussed with a view to the arising costs. (INIS)

48189 HYGIENIC JUDGEMENT OF FOODS TREATED WITH IONIZING RADIATION AND THE COMMISSIONING OF THEIR PUBLIC CONSUMPTION. Lindner, K. (Orszagos Elelmezes-es Taplalkozastudomanyi Intezet, Budapest). Izotoptechnika; 15: No. 3-4, 206-12(1972).

The present state of permission for consumption of irradiated foods in different countries and in Hungary is reported. (auth)

48190 INVESTIGATIONS ON THE RADIOSTERILIZABILITY OF PHARMACEUTICALS. DIRECTIVES FOR SELECTING DOSE. Hangay, Gy.; Bartha, T.; Haraszti, M. Izotoptechnika; 15: No. 3-4, 192-8(1972). (In Hungarian).

The physical radioresistance and effective sterilizing dose for eye ointments and injections and those of biochemical products were determined. (auth)

48191 PRESENT STATE OF RADIATION CONSERVATION OF FOODSTUFFS. Vas, K. (Kozponti Elelmiszeripari Kutato Intezet, Budapest). Izotoptechnika; 15: No. 3-4, 135-42(1972). (In Hungarian).

The present state and problems involved in permitting public consumption of irradiated foods are discussed. Recommendations are given for solving problems encountered in radiopreservation. (auth)

48192 REVIEW OF RECENT PROGRESS MADE IN THE RADIOSTERILIZATION OF MEDICAL PRODUCTS. Sztanyik, B. L. (International Atomic Energy Agency, Vienna). Izotoptechnika; 15: No. 3-4, 110-34(1972). (In Hungarian).

The industrial use of isotopic cobalt-irradiators in preference to that of accelerators is discussed. The advantages of radiosterilization were compared with conventional methods. The necessity of international standardization and national legislation is explained. (102 references) (auth)

LIFE SCIENCES

Radiation Effects on Biochemicals (External Source)

Refer also to abstracts 47840, 47841, and 48208–48213.

48193 (RLO–2045-6) UV MICROBEAM ON MITOSIS. Final Report. Bajer, Andrew S. (Oregon Univ., Eugene. Dept. of Biology). Aug 1972. Contract AT(45-1)-2230. 4p. Dep. NTIS.

The results of investigations on the effect of uv microbeams on the fine structure of the mitotic spindle and on chromosome movements in endosperm of Haemanthus katherinae are reported. The following results are given: the same doses do not produce the same effects in different cells; spindle fibers are rapidly disorganized following exposure; and chromosome movements were either slowed down or stopped completely depending on the dose. (E.R.B.)

48194 (UCLA–12-858) ANNUAL PROGRESS REPORT FOR THE PERIOD ENDING JUNE 30, 1972. (California Univ., Los Angeles. Lab. of Nuclear Medicine and Radiation Biology). 30 Jun 1972. 110p. Dep. NTIS.

In the division of biochemistry, research activities included: lipid metabolism in brain and membranes in development and aging; transport and turnover of lipids in the brain; control of lipid desaturation in Bacilli; lipid composition, function, and metabolism in marine organisms; and radiation chemistry of lipids. In the division of developmental biology, research activities included: enzyme induction and control by hormonal and serum factor; organ specific protein synthesis; and membrane function and specific receptors. In the division of environmental biology, research activities included: animal and plant ecology; nutrient and radionuclide cycling; chemical studies and soil factors; and spectroscopy. In the division of nuclear medicine, research activities included: leukemia biology; cardiac studies; total-body counter activities; radiopharmaceutical development; and clinical applications. In the division of radiobiology, research activities included: radiation chemistry of nucleic acid constituents; radiation biochemistry of nucleic acids and their constituents; cellular and mammalian radiobiology; radioinduced chemical changes in nucleic acids leading to biological damage; and radiation biochemistry of proteins and amino acids. Publications and reports issued during the reporting period are listed. (E.R.B.)

48195 INACTIVATION OF BIOLOGICALLY-ACTIVE DNA BY RADIATION-INDUCED PHENYLALANINE RADICALS. de Jong, J.; Loman, H.; Blok, Joh. (Vrije Univ., Amsterdam). Int. J. Radiat. Biol.; 22: No. 1, 11-21(Jul 1972).

To investigate the possibility of the involvement of organic radicals, e.g. those derived from amino acids, in the inactivation of DNA in living cells by ionizing radiation, a study was made, as a model system, of dilute solutions of the biologically-active DNA of the bacteriophage ΦX174 in the presence of relatively high concentrations of phenylalanine. The solutions were saturated with N_2, O_2 or N_2O and irradiated with ^{60}Co γ-rays. Under these conditions a negligible fraction of the primary water radicals reacted with DNA. Nevertheless inactivation of DNA occurred, due to reactions of amino-acid radicals. It was suggested that these reactions probably did not produce DNA chain breaks, but another type of nucleotide damage, not yet identified. In anoxic solutions the phenylalanine radicals could be reduced or oxidized by small amounts of cysteamine and paranitroacetophenone, respectively, which prevented their attack on DNA, resulting in an enormous protection. It was found that the ratio of breaks and other damages in DNA in the presence of cysteamine or paranitroacetophenone was considerably lower than in the case where simple attack by water radicals occurred. It was suggested that both compounds react with DNA radicals, thereby modifying the radiation damage. (auth)

48196 MOLECULAR AND CELLULAR REPAIR PROCESSES. Fifth International Symposium on Molecular Biology, Baltimore, Maryland, June 3–4, 1971. Beers, Roland F. Jr.; Herriott, Roger M.; Tilghman, R. Carmichael (eds.). Johns Hopkins Medical Journal, Supplement Number 1. Baltimore; Johns Hopkins University Press (1972). 282p. $17.50. (CONF-710611).

Separate abstracts were prepared for 13 of the 21 papers appearing in these proceedings. Three of the remaining papers appeared previously in NSA as abstract numbers 25: 46709, 25: 46947, and 26: 9498. The other five papers discuss: differences between DNA replication and repair; repair of freezing injury in mammalian cells; DNA synthesis, repair, and chromosomal breaks in eucaryotic cells; repair of alkylated DNA in mammalian cells; and the isolation and partial characterization of age-correlated oligo-deoxyribo-ribonucleotides with covalently bound aspartyl-glutamyl polypeptides. (E.R.B.)

For abstracts of individual papers see: 48197–48203 and 48208–48213.

48197 MAMMALIAN DEOXYRIBONUCLEASES ACTING ON DAMAGED DNA. Lindahl, Tomas (Karolinska Institutet, Stockholm). Johns Hopkins Med. J.; Suppl. No. 1, 3-13(1972).

From fifth international symposium on molecular and cellular repair processes; Baltimore, Md. (3 Jun 1971). See CONF-710611.

Both microorganisms and mammalian cells have the ability to remove various types of damaged nucleotide residues from their DNA. One mechanism of repair apparently involves the consecutive action of at least four different enzymes: an endonuclease that recognizes a particular type of DNA damage and catalyzes the formation of a single-strand break close to the damaged nucleotide(s), an exonuclease that excises this residue and a number of additional nucleotides, a DNA polymerase responsible for repair replication, and a DNA ligase that rejoins the remaining strand interruption. Enzymes of all four types have been found in microorganisms, and their function in DNA repair has been confirmed by the isolation of radiation-sensitive mutant strains with defective enzymes. As mammalian cells are also known to respond to radiation damage by DNA excision, repair replication, and joining of interrupted DNA strands, it appears likely that similar repair enzymes are present in higher organisms. A DNA ligase and a DNA polymerase have in fact been found in the nucleoplasm of mammalian cells. Because of the lack of radiation sensitive mutant cell types, it is not possible to prove directly whether these mammalian enzymes function in DNA repair in vivo. However, as the purified mammalian DNA ligase and DNA polymerase have biochemical properties similar to the corresponding microbial enzymes, it is a reasonable working hypothesis to assume that the mammalian enzymes are indeed involved in DNA repair. This indirect approach of comparing the biochemical properties of mammalian enzymes potentially functioning in DNA repair with microbial enzymes of known function has now been extended to several nucleases. (auth)

48198 GENETIC AND PHYSIOLOGICAL FACTORS RELATING TO EXCISION-REPAIR IN ESCHERICHIA COLI. Boyle, John M. (Christie Hospital and Holt Radium Inst. Manchester, Eng.). Johns Hopkins Med. J.; Suppl. No. 1, 14-33(1972).

From fifth international symposium on molecular and cellular repair processes; Baltimore, Md. (3 Jun 1971). See CONF-710611.

In 1964, the excision-repair hypothesis was proposed for the repair of ultraviolet (uv) light induced damage in DNA. The following three years saw the development of techniques that allowed the sequential steps of the process to be examined, but at the Brookhaven Symposium of 1967 barely any mention was made of the enzymes involved in these reactions. Since then, however, considerable progress towards the isolation and characterization of proteins having the expected properties of repair enzymes has been made. Although the excision-repair hypothesis was developed to explain the repair of uv-damaged DNA containing cyclobutyl pyrimidine dimers, this mechanism and that of recombination repair have been implicated in the repair of DNA damaged by a variety of other agents including ionizing radiation and radiomimetic chemicals. The rapidity of these developments has been possible largely because of the availability and ease of genetic manipulation of mutant strains of bacteria and their viruses. In this paper, recent information concerning enzyme activities thought to be responsible for steps in excision repair are reviewed and the role that damage to membranes might play in excision repair is discussed. (E.R.B.)

48199 DNA POLYMERASES OF ESCHERICHIA COLI. Knippers, Rolf; Ferdinand, Franz-Josef; Straetling, Wolf (Max-Planck-Gesellschaft, Tuebingen, Ger.). Johns Hopkins Med. J.; Suppl. No. 1, 34-44(1972).

From fifth international symposium on molecular and cellular repair processes; Baltimore, Md. (3 Jun 1971). See CONF-710611.

Recently several groups have described a deoxynucleotide polymerizing enzyme in Escherichia coli cells that had been overlooked before. This enzyme has risen to sudden prominence due to the fact that it was the only DNA polymerase that could be purified from an E. coli strain lacking the well-known DNA polymerase I, the enzyme studied extensively by Kornberg and his group. The newly-discovered DNA polymerase II, therefore, became a possible candidate for the polymerizing factor in the replicating apparatus of the bacterial cell. This conclusion, however, can be drawn only by way of exclusion. No direct proof (or disproof) for its participation in DNA replication is known so far. In this paper, some relevant biochemical properties of the known E. coli DNA polymerases will be compared, and an attempt will be made to define the biological functions of these enzymes. (auth)

48200 PHOTOENZYMATIC REPAIR OF DNA. I. INVESTIGATION OF THE REACTION BY FLASH ILLUMINATION. Harm, Walter; Rupert, Claud S.; Harm, Helga (Univ. of Texas, Dallas). Johns Hopkins Med. J.; Suppl. No. 1, 53-63(1972).

From fifth international symposium on molecular and cellular repair processes; Baltimore, Md. (3 Jun 1971). See CONF-710611.

To escape the lethal effects of UV or other damaging agents, organisms have developed various repair mechanisms. They operate in two principal ways: Either the uv lesion is reversed, that is, the photochemically altered base is restored to its original condition or to something functionally equivalent; or a DNA segment containing a lesion is replaced. While the replacement principle is variably employed by different dark repair systems, the only case known so far to use the reversion principle is photoenzymatic repair. Its mechanism is simpler than that of any known type of dark repair since it involves the action of only a single enzyme: the photoreactivating enzyme (PRE). This enzyme monomerizes uv-induced pyrimidine dimers in situ, that is, it reverses the potentially lethal lesion while leaving the DNA structure fully intact. The action of PRE has an absolute requirement for an outside factor, light, which makes experimental control of the reaction rather easy. Therefore, it is not surprising that photoenzymatic repair has been investigated in more detail than any other kind of repair. In this paper, the potential value of the flash photolysis method for studying photoenzymatic repair and the basic considerations that enable us to use this method for a quantitative analysis are discussed. A few applications of the method, that is, establishing the net reaction kinetics of complex formation and determining the number of PRE molecules, are demonstrated. (E.R.B.)

48201 PHOTOENZYMATIC REPAIR OF DNA. II. PHYSICAL/CHEMICAL CHARACTERIZATION OF THE PROCESS. Rupert, Claud S.; Harm, Walter; Harm, Helga (Univ. of Texas, Dallas). Johns Hopkins Med. J.; Suppl. No. 1, 64-78 (1972).

From fifth international symposium on molecular and cellular repair processes; Baltimore, Md (3 Jun 1971). See CONF-710611.

The photoenzymatic repair of ultraviolet damage to DNA is an explicitly recognized mechanism that can be carried out in vitro. Besides being the first such repair process to be discovered, it is also the simplest: a single enzyme acting on a single class of pyrimidine photoproducts to reconvert them to the original bases. Therefore, it is probably the most primitive in an evolutionary sense. Yet, although this mechanism still confers a survival advantage on cells exposed to sunlight and would presumably continue to be selected for under these circumstances, it is far less versatile in the range of damage it can handle than the excision-resynthesis and recombination repairs. Like the incising endonuclease that performs the initial step of excision-resynthesis repair, and like DNA-dependent RNA polymerase, the photoreactivating enzyme (PRE) must recognize and attach to appropriate sites on the nucleic acid. The forces leading to such recognition and attachment have a general interest beyond the particular enzyme system in which they are studied. The information that can be obtained about this enzymatic repair is clearly of a kind that concerns the elementary processes of individual reaction steps. It is entirely possible that a mix of mechanisms, including electrostatic and hydrophobic interactions, conformational changes, and solvent effects, occurs in all parts of the reaction. The pH, for example, affects all steps, including the light-dependent one, but this has not been thoroughly explored. The effects of dielectric constant of the medium, as well as the interactions of pH and the ionic strength effect also remain to be worked out. The photoenzymatic repair process, in spite of its apparently secondary importance in cellular survival today, remains curiously close to the leading edge of our knowledge about repair processes. By analogy and example it still seems capable of illustrating things about nucleic acid enzymes, including repair enzymes, that are hard to study in other systems. (E.R.B.)

48202 PHOTOENZYMATIC REPAIR IN ANIMAL CELLS. Cook, John S. (Oak Ridge National Lab., Tenn.). Johns Hopkins Med. J.; Suppl. No. 1, 79-94(1972).

From fifth international symposium on molecular and cellular repair processes; Baltimore, Md. (3 Jun 1971). See CONF-710611.

Enzymatic photoreactivation—an enzyme-mediated, light-dependent reversal of uv radiation damage to DNA—has been demonstrated in a variety of plant and microbial cells and is almost ubiquitously distributed throughout the animal kingdom. Moreover, in any animal species in which photoreactivating enzyme (PRE) activity is found, it is found in virtually all the tissues. A major exception to these generalizations is seen in the placental mammals, where neither biological photoreactivation nor PRE activity have been unequivocally demonstrated. Although PRE activity can be demonstrated readily in the dedifferentiated fibroblasts of fish, amphibia, reptiles, birds, and marsupials, it is not found in the fibroblasts of man, hamster, or mouse. Although skin is the tissue most vulnerable to ultraviolet radiation (uv) and potentially the most susceptible to photoreactivation, PRE activity could not be demonstrated in mammalian skin from a variety of sources. Although eggs and zygotes of many animals are exposed to the environment and are susceptible to inactivation and concurrent photoreactivation by solar radiation, the embryos of rats and cattle show no PRE activity even in very early stages of embryogenesis. Despite the absence of PRE activity in placental mammals, such activity is probably present in nearly all the cells of all other animals. In fact, in experiments with tissues from animals that had not been previously screened for PRE activity, these tissues showed the desired activity. Photoreactivation in the cells of metazoa, just as in microbial cells, may be observed by a number of criteria: the survival of uv-irradiated cells may be enhanced in the light; the inhibited growth rate of irradiated cells may be partially restored in the light, as may the rates of DNA synthesis. Cyclobutyl pyrmidine dimers, which are the principal photoproducts in the DNA of uv-irradiated cells, are the only known substrate for PRE, and their disappearance (reversal to pyrimidine monomers) may be observed in vivo as a consequence of exposure to photoreactivating light. In vitro, the enzymatic activity from cell extracts can be shown with the sensitive Hemophilus assay. In all of the studies with metazoan cells a case has never been found in which one of these assays was positive while another was negative. Photoreactivation in metazoa appears to operate by a mechanism identical to that described for microbial systems. (E.R.B.)

48203 RECOMBINATIONAL REPAIR IN UV-IRRADIATED ESCHERICHIA COLI. Howard-Flanders, Paul; Rupp, W. Dean (Yale Univ., New Haven). Johns Hopkins Med. J.; Suppl. No. 1, 212-25(1972).

From fifth international symposium on molecular and cellular repair processes; Baltimore, Md. (3 Jun 1971). See CONF-710611.

Molecules of intermediate density were detected in the sheared single-stranded DNA obtained from uv-irradiated, but not control bacteria. These intermediate density molecules may be due to uv-induced genetic exchanges between sister duplexes formed when DNA containing damaged bases is replicated. To judge from the fraction of molecules that are of intermediate density, one single-strand sister exchange occurs for every one to two pyrimidine dimers in the DNA that undergoes replication. These exchanges may underlie the reconstruction of high molecular weight templates that become available for DNA synthesis 1 to 2 hrs after irradiation and provide a basis for the survival of colony-forming ability. (auth)

Radiation Effects on Cells (External Source)

Refer also to abstracts 48196 and 48258.

48204 SIZE DISTRIBUTION OF L CELL AFTER X-IRRADIATION WITH 5000R. Megumi, Tsuneo; Hosokawa, Yasushi; Sato, Yuji. Annu. Rep. Radiat. Center Osaka Prefect.; 12: 108-10(1971).

A Coulter counter connected with a multi-channel pulse height analyzer was used for making accurate and rapid measurements of volume distributions of cultured L cells before and after exposure to 5000 R x radiation. Unirradiated cells measured about 1000 μ^3; following irradiation there was greater variation in cell volume with the smallest cells measuring 600 μ^3 and the largest 1500 μ^3. One day later some cells increased to a volume of 1900 μ^3; these giant cells appeared to result from a failure of the cell division mechanism. Twenty-four days later it was observed that the cell population was divided into two groups, one composed of smaller cells, and the other of giant cells. (H.L.W.)

48205 RADIOPROTECTIVE EFFECT OF STREPTOMYCIN ON HUMAN CHROMOSOMES. Borodkin, P. A. Med. Radiol.; 17: No. 6, 73-5(Jun 1972). (In Russian).

The effect of streptomycin on the production of chromosomal aberrations in human blood cultures was investigated. The administration of streptomycin in amounts of 600 to 1,600 units/ml of blood 30 min prior to a 500 R irradiation dose leads to a reduction of the aberrant cells by 25 to 30% as compared to the controls. (tr-auth)

48206 PATTERN OF DAMAGE OF CHROMOSOMES FROM CULTURED AMPHIBIAN LEUCOCYTES AFTER X-IRRADIATION OF CELLS AT DIFFERENT STAGES OF THE CELL CYCLE. II. X-IRRADIATION OF G_0 CELLS. Pankova, N. V. (Inst. of Developmental Biology, Moscow). Genetika; 8: No. 4, 71-7(Apr 1972). (In Russian).

Aberrations occurring in in vitro frog leukocytes after x irradiation of blood (200 R) at the G_0 phase were analyzed. The data were compared with the results obtained by other authors in plants irradiated at the same phase of the cell cycle. Two thousand eight hundred five metaphases from eight samples were analyzed. The most frequent type of aberration was paired chromosomal deletion, their value reached 48% of all the aberration types observed. The values of paired chromosomal deletions exceeded that of dicentrics by 10%. On the contrary, in plants, chromosomal exchanges (dicentrics) were the prevailing type, while chromosome tip deletions remained within the limits of the natural mutation process. In leukocytes of irradiated blood of frogs, an increase in the chromatid aberration level was revealed (in comparison with the control). The frequency of chromatid aberrations in experiments reached 4.5%, while in controls it was close to 0.6%. The data concerning the radiation induced damages of amphibian and plant chromosomes enable one to postulate the existence of differences in the patterns of damage in plant and animal cells. (auth)

48207 REPAIR OF X-RAY-INDUCED CHROMOSOME ABERRATIONS IN STIMULATED AND UNSTIMULATED HUMAN LYMPHOCYTES. Wolff, Sheldon (Univ. of California, San Francisco). Mutat. Res.; 15: No. 4, 435-44(Aug 1972).

The repair time for chromosome breaks induced by x-irradiation of unstimulated (G_0) and stimulated (G_1) human lymphocytes has been determined by dose fractionation studies. In both types of cells repair time was approximately 4 to 5 h. Treatment with hydroxyurea, a DNA synthesis inhibitor, did not prevent or delay the rejoining of broken chromosomes, whereas treatment with cycloheximide, a potent protein synthesis inhibitor, did. Thus, the repair of radiation-induced chromosome breaks in human lymphocytes is similar to the repair observed with plant cells. (auth)

48208 REPAIR OF SUBLETHAL RADIATION INJURY AND THE REJOINING OF RADIATION-INDUCED DNA BREAKS BY CULTURED MAMMALIAN CELLS: ARE THEY RELATED? Dalrymple, Glenn V.; Moss, A. J. Jr.; Baker, Max L.; (and others) (Little Rock Veterans Hospital, Ark.). Johns Hopkins Med. J.; Suppl. No. 1, 125-39(1972).

From fifth international symposium on molecular and cellular repair processes; Baltimore, Md. (3 Jun 1971). See CONF-710611.

The results support the notion that radiation-induced single-strand breaks represent reparable radiation injury. The presence or absence of large numbers of single-strand breaks does not correlate with increased lethality. Treatments, such as dinitrophenol, which prevent rejoining, if anything, enhance the repair of sublethal injury. The question of double-strand DNA breaks, however, still has not been completely settled. Whether cultured mammalian cells rejoin double-strand breaks or not is not the point at issue. The rejoining of double-strand breaks by no means guarantees that normal DNA will result. Consequently, this point must remain an unanswered question. (auth)

48209 RESTORATION OF THE DNA STRUCTURE IN X-IRRADIATED EUCARYOTIC CELLS: IN VITRO AND IN VIVO. Lett, J. T.; Sun, C.; Wheeler, K. T. (Colorado State Univ., Fort Collins). Johns Hopkins Med. J.; Suppl. No. 1, 147-58 (1972).

From fifth international symposium on molecular and cellular repair processes; Baltimore, Md. (3 Jun 1971). See CONF-710611.

The ability of eucaryotic cells to rejoin radioinduced DNA strand breaks was studied. It was found that when dividing Chinese hamster ovary cells were x-irradiated at a dose of 22 krads and incubated up to 6 hrs in vitro, 97% of the strand breaks within the DNA subunits were rejoined. The fate of the other 3% of the strand breaks produced at this dose is not known. In order to compare the ability of nondividing cells to rejoin DNA strand breaks in vivo, canine cerebellar neurons were γ-irradiated at a dose of 5 Krads and incubated for up to 13 hrs (and longer) in vivo. During the initial stages of incubation in vivo, the DNA subunits are rejoined in a manner similiar to that for the dividing cells in vitro. After 5 hrs, the amount of subunit decreased again and a significant proportion of the subunits were slowly sedimenting species. (E.R.B.)

48210 RECOVERY AND REPAIR IN CHINESE HAMSTER CELLS FOLLOWING UV-IRRADIATION. Humphrey, R. M.; Meyn, R. E. (Univ. of Texas, Houston). Johns Hopkins Med. J.; Suppl. No. 1, 159-67(1972).

From fifth international symposium on molecular and cellular repair processes; Baltimore, Md. (3 Jun 1971). See CONF-710611.

Evidence was presented indicating that recovery between fractionated doses of uv radiation is both cell strain and cell cycle dependent. Since a cell-age response function is evident in a cell line, which does not exhibit recovery (B-14), it is probable that this particular form of recovery does not play an important role in determining the cell-age dependent response. Data from experiments with synchronized populations support the model suggested by Rauth that for survival cells modify uv damage during the subsequent replication of their DNA. Chinese hamster ovary cells exhibit recovery between fractionated doses of uv and B-14 cells do not. However, both cell lines appear to have the capability to bypass uv-induced photoproduct. Therefore, the bypass mechanism does not correlate with recovery in these cells. (auth)

48211 FACTORS WHICH INFLUENCE THE EXPRESSION OF RADIATION DAMAGE BY MAMMALIAN CELLS. Belli, James A. (Harvard Medical School, Boston). Johns Hopkins Med. J.; Suppl. No. 1, 168-73(1972).

From fifth international symposium on molecular and cellular repair processes; Baltimore, Md. (3 Jun 1971). See CONF-710611.

In summary, mammalian cells in culture are able to repair potentially lethal radiation damage, if provided a minimum growth environment after a single exposure. When exposure to this environment is delayed until the first or second postirradiation division, nonviable daughter cells are also able to repair their segregated damage. During the development of a colony, there exists a subpopulation the members of which have reached the end of their divisional history and a substantial proportion of this population can be rescued if provided appropriate conditions. (auth)

48212 UNSCHEDULED DNA SYNTHESIS AND CELLULAR RECOVERY IN VARIOUS MAMMALIAN CELL LINES. Shaeffer, James; Merz, Timothy (John Hopkins Univ., Baltimore). Johns Hopkins Med. J.; Suppl. No. 1, 174-81(1972).

From fifth international symposium on molecular and cellular repair processes; Baltimore, Md. (3 Jun 1971). See CONF-710611.

There appears to be no causal relation between x-ray induced unscheduled DNA synthesis and cell recovery, based primarily on the lack of unscheduled synthesis in the rat kangaroo kidney line. Nor does there appear to be any relation between x-ray induced unscheduled synthesis and cell sensitivity. Unscheduled DNA synthesis appears to be related directly to chromosome number, while the relation of unscheduled synthesis to DNA content per cell remains unclear. The rat kangaroo kidney line exhibits neither uv nor x-ray induced unscheduled DNA synthesis, supporting the hypothesis that, excluding the incision endonuclease needed for uv repair, both uv and x-ray stimulated unscheduled DNA synthesis involve common enzyme systems. (auth)

48213 EFFECT OF ULTRAVIOLET LIGHT AND A POTENT CARCINOGEN, 4-NITROQUINOLINE 1-OXIDE, ON MAMMALIAN CELLS AND THEIR SENDAI VIRUS CARRIER CULTURES. Yamamoto, Nobuto; Morita, Osayuki; Satoh, Tsugio (Temple Univ., Philadelphia). Johns Hopkins Med. J.; Suppl. No. 1, 248-53(1972).

From fifth international symposium on molecular and cellular repair processes; Baltimore, Md. (3 Jun 1971). See CONF-710611.

A potent carcinogen, 4-nitroquinoline 1-oxide (4NQO), inactivates bacteria and induces a prophage. Many 4NQO-sensitive mutants of Salmonella typhimurium were isolated and it was found that all the 4NQO-sensitive mutants were extremely sensitive to ultraviolet light (uv) and subdivided into the two groups: host cell reactivation minus (hcr$^-$) mutants lacking repair activity for uv-damaged infecting phage and recombination deficient (rec$^-$) mutants. Furthermore, uv-sensitive bacterial mutants were also found to be sensitive to 4NQO. The above finding suggests that 4NQO or its metabolic intermediates reacted with bacterial genome, resulting in the damage of DNA, and that the damaged bacterial DNA was reparable by the same mechanism as uv-damaged DNA. In this presentation, studies on DNA repair in HeLa and human osteosarcoma cell lines, and their carrier cultures containing Sendai virus are described. Not only cellular DNA repair but also that of herpes simplex virus as a foreign DNA was investigated. (auth)

48214 ABOUT THE EFFECT OF SUBLETHAL X-RAY DOSES ON THE MITOCHONDRIA OF CULTURED CELLS WITH SIMULTANEOUS DEMONSTRATION OF THE Mg^{++}-DEPENDENT ADENOSINTRIPHOSPHATASE. Ahrens, R. (Univ., Bonn). Strahlentherapie; 143: No. 5, 576-87(May 1972). (In German).

The effect of sublethal doses (1200 and 2400 R) of x rays on the mitochondria of cultured chicken heart cells can mainly be seen by light microscopy as mitochondrial enlargements. The mitochondria-specific, Mg^{++}-dependent ATPase, which was simultaneously demonstrated as an indication of function, is always still evident. Within 16 hours the mitochondria become normal again. By electron microscopy, the damages can be seen as dissolutions of the interior structures of the mitochondria. Especially after 2400 R, parts of the mitochondria are considerably damaged, while others remain nearly normal. The ATPase proves to be strongly bound to structures. After 2400R, an increased formation of mitochondria-buds occurs. The microscopic results are assured by a statistical analysis of the micrographs. (auth)

Radiation Effects on Microorganisms (External Source)

Refer also to abstracts 48198–48201, 48203, and 48258.

48215 CYBERNETIC MODEL FOR RADIATION REACTIONS IN LIVING CELLS. 1. SPARSELY-IONIZING RADIATION; STATIONARY CELLS. Kappos, A.; Pohlit, W. (Gesellschaft fuer Strahlen- und Umweltforschung mbH, Framkfurt am Main). Int. J. Radiat. Biol.; 22: No. 1, 51-65(Jul 1972).

A model for radiation reactions in living cells is described. It assumes three different states of the cell. State A is a cell which can grow up to a macrocolony; in state B and C the cell is not able to do so. In state B an essential molecule of the cell has been damaged reparably, in state C irreparably. The sensitivity of the cell is assumed to increase with absorbed dose and to be reduced by recovery reactions in the cell. This could be explained, for example, by indirect radiation reactions with molecules competing with the essential molecule. These competing molecules could be replenished by the cell using an internal energy reservoir. Methods for the experimental determination of all parameters appearing in this model are described. Experiments with stationary diploid yeast cells, irradiated with x-rays, showed that the time-constants of recovery and repair were of the same order of magnitude, but dependent on the time interval between or after irradiations, and were dependent on absorbed dose. It is suggested that this model could be applied also to radiation reactions in other types of cells, and to other ionizing radiations. (auth)

48216 EFFECT OF GAMMA-RAYS ON SURVIVAL OF COLORED STRAINS OF ASPERGILLUS NIGER. Hannan, M. A.; Muttaqi, I. A. (Atomic Energy Centre, Dacca, Pakistan). Curr. Sci. (India); 41: No. 14, 538(20 Jul 1972).

Conidia of three colored variants derived from γ-irradiated Aspergillus niger were exposed along with conidia from the parent strain to 20, 30, and 40 kR of γ radiation from a ^{60}Co source. The radiosensitivity of each of the four groups of conidia was determined on the basis of percent survival (colony formation on nutrient agar) following exposure in comparison to an unexposed sample of each variant. One of the variants exhibited an increased radiosensitivity in comparison to the parent strain. The role of the different colors in radiosensitivity of the variants is discussed. (E.R.B.)

48217 GENETIC AND ENZYMATIC ANALYSIS OF A GENE CONTROLLING UV SENSITIVITY IN NEUROSPORA CRASSA. Tuveson, R. W. (Univ. of Illinois, Urbana). Mutat. Res.; 15: No. 4, 411-24(Aug 1972).

The upr-I gene controlling uv sensitivity in Neurospora crassa has been transferred from a microconidial strain into a macroconidial strain. The properties of the strain with respect to uv sensitivity and photoreactivation (PR) have been modified in the macroconidial background leading to an enhancement of resistance to uv by a factor of about 2 and some suggestion of enzymatic PR. The upr-I gene confers sensitivity to nitrous acid to about the same degree as that for uv. However, inactivation of strains carrying the upr-I gene by white light in the presence of photosensitizing dyes is equivalent to that of strains exhibiting normal sensitivity to uv. Although in vivo enzymatic PR in strains carrying the upr-I gene is impaired, enzymatic analysis with the Hemophilus influenzae transformation systems in vitro reveals that strains carrying the upr-I gene possess a functional PR enzyme. It is suggested that the upr-I gene may control nuclease(s) which compete with the PR enzyme for substrate. The upr-I gene has been located on linkage group IL about 1.6 map units proximal to mating type. The gene has been shown to be without effect on ascus and ascospore development and to have no significant effect on crossing-over. (auth)

48218 GENETIC BASIS FOR UV-RESISTANCE IN SALMONELLA. I. LOCATION OF uvr-A GENE ON SALMONELLA TYPHIMURIUM CHROMOSOME. Andereeva, I. V.; Kiryushkina, A. A.; Pokrovskii, V. N.; Skavronskaya, A. G. (Inst. of Epidemiology and Microbiology, Moscow). Genetika; 8: No. 4, 117-22 (Apr 1972). (In Russian).

Using transductional and conjugational techniques, a genetic mapping of the mutation affecting uv-resistance in Salmonella typhimurium P5 was performed. The analysis of recombinants for unselective markers elucidated that uvr gene in the mutant P5 of S. typhimurium is located clockwise from the arg group of genes (A, C, F, H). The investigated gene is cotransduced with mal B marker (2.6%). The location of the gene is similar to one of the uvr A gene in Escherichia coli. The peculiarity of the gene compared with E. coli gene is in the absence of cotransduction with met A and in a lower frequency of cotransduction with mal B (2.6% as compared with 50 to 68% in E. coli). (auth)

48219 CHARACTERISTICS OF Hcr-AND Lon-MUTANTS OF SALMONELLA TYPHIMURIUM LT2. Pokrovskii, V. N. (Inst. of Epidemiology and Microbiology, Moscow). Genetika; 8: No. 4, 110-16(Apr 1972). (In Russian).

Characteristics of Hcr- and Lon-mutants of Salmonella typhimurium LT2 were studied. Two mutants were established; one of them was responsible for uv-sensitivity, the other one being responsible for the sensitivity to high temperature. As it was shown by the investigation of the capacity of repairing uv lesions in a buffer, the rate of survival increased under these conditions in Lon-mutants only, remaining unchanged in mutants with a disturbed system of dark repair. In experiments with mutants having defects in the system of dark repair, the death rate at the logarithmic stage of growth was shown to be lower in lysogenic strains of Salmonella, while at the stationary stage of growth no significant difference in the death rate was observed between lysogenic and non-lysogenic bacteria. In Lon-mutants, no difference in the rate of survival between lysogenic and non-lysogenic bacteria, depending on the stage of growth, was observed. Spontaneous induction of phage P-22 was relatively frequent in all the mutants studied, particularly in Lon-mutants. No induction of the phage P-22 was observed in Lon-mutants. The efficiency of titration of the phage P-22 was relatively low (22 to 35%) in lysogenic Lon-strains. (auth)

Radiation Effects on Plants (External Source)

Refer also to abstracts 48193, 48215, and 48255.

48220 (ORO-3299-117) EFFECTS OF IONIZING RADIATION ON PLANT SPECIES, POPULATIONS, AND ECOSYSTEMS. Progress Report, September 1, 1971–August 31, 1972. McCormick, J. Frank (North Carolina Univ., Chapel Hill). 1972. Contract AT(40-1)-3299. 5p. Dep. NTIS.

Studies were conducted on interactions of beta and gamma radiation with other environmental stresses on plant populations. Objectives were to survey the radiosensitivities of plant species characteristic of the experimental ecosystems; to establish suitable criteria for evaluating radiosensitivities; to analyze the radiosensitivities of the various life cycle stages of each species; and to determine the nature and extent to which environmental conditions and physiological stresses modify basic radiosensitivities of plant species and, in turn, to determine the effects of irradiation on physiological tolerance to these species. Direct and indirect effects of radiation on a variety of natural ecosystems were also investigated. Studies were completed on population dynamics of Euterpe globosa and Viguiera porteri and the effects of beta radiation from simulated fallout on the reproductive potential of a dominant plant species, Viguiera porteri, in a natural community. (H.L.W.)

48221 (ORO-4241-2) STUDY OF THE BIOCHEMICAL EFFECTS OF IONIZING AND NONIONIZING RADIATION ON PLANT METABOLISM DURING DEVELOPMENT. Progress Report, August 15, 1971–August 31, 1972. Klein, William H. (Smithsonian Institution, Rockville, Md. (USA). Radiation Biology Lab.). 1972. Contract AT(40-1)-4241. 40p. Dep. NTIS.

A new method for isolating and purifying phytochrome completely free from sulfhydryl reagents was developed. The phytochrome isolated by this procedure is believed to be more nearly like native phytochrome, is stable with little loss of photoreversibility over a wide pH range including pH 6 to 7, and has an isoelectric point between 7.5 and 8.0. Comparative data of spectral distribution of total sky irradiance for no cloud, 100% sunshine days indicate large shifts in ultraviolet and infrared between Rockville, Maryland and Washington, D.C. For the same solar secant, the energy values for the blue and green portions of the spectrum measured at Barrow, Alaska, and much higher than at Washington or Rockville. Ultraviolet values vary rapidly at Rockville by a factor 10 on a day to day basis. The reason for this rapid variation is unknown but probably related to smog fluctuations. A prototype scanning radiometer sensitive to a level of 0.25×10^{-6} watts · cm^{-2} was constructed and is being calibrated for low level measurements near sunrise and sunset. Phytochrome mediated responses of developing Arabidopsis seed to changes in light quality are localized within the developing seed, with no influence of rosette or cauline leaves. No transmission of a controlling factor occurs from one floral branch to another. (auth)

48222 INDUCTION OF CHLOROPHYLL MUTATIONS IN PEAS (PISUM SATIVUM L.) BY MEANS OF GAMMA-IRRADIATION. Vasileva, M.; Mekhandzhiev, A. (Akademiya na Selskostopanskite Nauki, Sofia). Genet. Selek.; 2: No. 4, 111-20(1971). (In Bulgarian).

Data are given about the chlorophyll mutants obtained after gamma irradiation (^{60}Co source) in 11 pea varieties (Ramonskii 77, Voronezhskii, Kazanskii, Raman, Urozhainii, Iregi 5, Krasnodarskii, Rekord, Kormovoi 24, Krasnoufimskii 40, and Chishminskii 39). The varieties tested responded rather differently to varying irradiation doses. The rate used to induce the highest chlorophyll mutation percentage in the different varieties was not the same. No regular influence of the irradiation rate on the appearance of chlorophyll mutants was observed. Chishminskii 39, Ramonskii 77, and Voronezhskii showed highest degree of mutability. (auth) (INIS)

48223 CYTOGENETICAL ANALYSIS OF MUTANTS OF 56-CHROMOSOME TRITICALE. I. ANALYSIS OF VARIABILITY OF 56-CHROMOSOME TRITICALE AFTER IRRADIATION AND IN THE CONTROL. Kozlovskaya, V. F.; Khvostova, V. V. (Inst. of Cytology and Genetics, Novosibirsk, USSR). Genetika; 8: No. 4, 5-14(Apr 1972). (In Russian).

Variability in wheat-rye amphidiploids 25AD20 was studied in plants grown from seeds treated with gamma rays and fast neutrons and in control plants grown from untreated seeds. Plants grown from irradiated seeds and control plants varied considerably both in their morphological characters and chromosome number, the latter being observed not only between different plants but also between different cells of the same plant. The variability of forms of amphidiploids in the experiment and in the control was the result of aneuploidy. However square-head and speltoid forms were discovered among experimental plants by a detailed analysis of morphological characters and of subsequent cytological studies. Their appearance was probably due to the effect of radiation. A number of forms similar phenotypically to wheat were distinguished among experimental and control plants. Like hexaploid wheat, all the experimental plants had 42 chromosomes. It is possible, however, that some wheat chromosomes have insertions of Secale chromosomes or mutations initiated as the result of irradiation, since various wheat-like forms differ from one another in their morphological characters. (auth)

48224 USE OF INDUCED MUTANTS FOR GRAIN CHARACTERS IN DURUM WHEAT BREEDING. Prasad, M. V. R. (Central Arid Zone Research Inst., Jodhpur, India). Curr. Sci. (India); 41: No. 15, 570-1(5 Aug 1972).

Macaroni wheat (Triticum durum, 2n = 48) is widely cultivated in central and peninsular India and is chiefly valued for its lustrous and bold grains. However, the recently evolved dwarf durum lines possess lesser number of spikelets (14 to 18) per ear and the grains also are unattractive; as such they are not acceptable to farmers for cultivation under irrigated and high fertility conditions. Another tetraploid species of Triticum carthlicum (2n = 48) commonly known as Persian wheat, tall in height, produces high number of spikelets per ear (22 to 26), but gives highly shrivelled, dirty brown, and small grains. Seeds of T. carthlicum were irradiated with gamma rays at a dose of 40 kR and also treated with aqueous solutions of chemical mutagens, viz., ethyl methane sulfonate and nitrosomethyl urea at 0.2% and 0.015% concentrations respectively for 12 hrs with intermittent shaking at 30°C after pre-soaking in distilled water for 5 hrs. In the M_2 generation of nitrosomethyl urea treatment, two mutants with bolder and attractive grains were isolated. In the subsequent generations these were crossed with a variety of dwarf durum HD 4501. In the F_2 generations, dwarf segregants combining higher grain weight, attractive grain color and higher grain number were isolated. These were carried forward up to F5 generation and presently are found ideally suited for cultivation under irrigated and high fertility conditions. This shows that the mutant gene (s) for grain characters are independent of the genes concerning spikelet or grain number and can be transferred conveniently, unlike the normal condition wherein high grain weight is invariably associated with low spikelet number and vice versa. Thus induced mutants involving new genes are of great importance in plant breeding, in overcoming undesirable character associations which otherwise would be very hard to break by means of conventional breeding procedures. (auth)

48225 MODIFICATIONS OF THE RETICULO-ENDOPLASMIC OF CYTOSOMES, AND OF MITOCHONDRIA IN THE BUD OF THE CORNELIAN CHERRY (CORNUS MAS L.) GAMMA IRRADIATED WITH RADIOCESIUM. Coulon, Josiane; Fabries, Michel (Univ., Aix-Marseille. CEN de Cadarache, Saint-Paul-les-Durance, France). Compt. Rend., Ser. D; 274: No. 11, 1686-8 (13 Mar 1972). (In French).

The irradiated cells presented considerable development of the endoplasmic reticulum and an alteration of the mitochondria. (France)

48226 EFFECT OF REIRRADIATION ON RADIORESISTANCE IN PEANUTS (ARACHIS HYPOGAEA L.). Emery, D. A. (North Carolina State Univ., Raleigh). Radiat. Bot.; 12: No. 3, 137-50 (Jul 1972).

The radioresponse of 20 M_2 families of cultivated peanuts, Arachis hypogaea L., representing proven radioresistant, radiosensitive, and radioresistant x radiosensitive hybrid genotypes was determined in plants treated twice with irradiation, seven generations previously, and one generation previously. Each cycle of irradiation consisted of 15 krads of x- or γ-rays applied to dormant seeds. Further evaluations were made of the same families for mutation frequency and fruit yield in subsequent generations. Statistically significant differences are reported. (auth)

48227 POST-IRRADIATION TEMPERATURE EFFECTS IN DRIED SPORES OF OSMUNDA REGALIS. Dodd, N. J. F.; Ebert, M. (Christie Hospital and Holt Radium Inst., Manchester, Eng.). Radiat. Bot.; 12: No. 3, 151-8(Jul 1972).

Dried spores of Osmunda regalis were electron-irradiated (3 to 5 krads) in the absence of O_2, cultured, and scored for survivors. The damage produced by anoxic irradiation could be enhanced by O_2, after irradiation, to give oxic damage. Anoxic heating of irradiated spores reduced the concentration of precursors of oxic damage by 30 to 40%. The apparent activation energy for this thermal annealment was 21 ± 3 kcal $mole^{-1}$. Annealment did not affect the rate of subsequent reaction of the remaining precursors with O_2. Development of oxic damage involved two stages, an oxygen-dependent reaction followed by an oxygen-independent reaction. The influence of temperature, between 0 and 50°C, on the two stages of development of damage was studied. Both stages had an apparent activation energy of 11 ± 2 kcal $mole^{-1}$. It is suggested that the activation energy for the two reactions leading to oxic damage is a reflection of the nature of the matrix in which the damage develops. (auth)

48228 GAMMA IRRADIATION OF CORN PLANTS. EFFECTS OF EXPOSURE, EXPOSURE RATE, AND DEVELOPMENTAL STAGE ON SURVIVAL, HEIGHT, AND GRAIN YIELD OF TWO CULTIVARS. Killion, D. D.; Constantin, M. J. (UT-AEC Agricultural Research Lab., Oak Ridge, Tenn.). Radiat. Bot.; 12: No. 3, 159-64(Jul 1972).

Two cultivars of corn (Zea mays L., cv. "WF9 x 38-11" and "Golden Bantam") were treated at different developmental stages with ^{60}Co γ-radiation at different exposures and rates. The exposures were as follows: 0.5 kR at 16 and 32 R/min, 1.0 kR at 8, 16, and 32 R/min, 1.5 kR at 16 and 32 R/min, 2.0 kR at 4, 8, 16 and 32 R/min, 3.0 and 4.0 kR at 4 and 8 R/min, and 5.0 kR at 4 R/min. When given an acute exposure in the seedling stage, Golden Bantam was more sensitive than WF9 x 38-11 as measured by a reduction in survival and grain yield. A plot of the effect of exposure rate on the level of exposure required to eliminate grain production (YD_{100}) gave parallel curves for the two cultivars and showed dependence of YD_{100} on exposure rate below 16 R/min. Additional experiments demonstrated that WF9 x 38-11 was affected more severely by acute irradiation during tassel and ear primordia initiation than during the vegetative stage as measured by a reduction in plant height and grain yield. When chronic irradiation was used, WF9 x 38-11 plants exposed during the vegetative and gametogenic stages were affected more severely than those exposed during the embryogenic stage as measured by a reduction in height and grain yield. Chronic exposures ranged from 3.6 to 9.7 kR at rates varying from 7.6 to 19.8 R/hr over 3 separate 21 day periods. (auth)

48229 RADIOSENSITIVITY OF A TRIPLOID CLONE OF TRADESCANTIA DETERMINED IN ITS STAMEN HAIRS. Ichikawa, S. (Kyoto Univ.). Radiat. Bot.; 12: No. 3, 179-89(Jul 1972).

Somatic mutations from blue to pink were induced by ^{60}Co γ-rays in the stamen hairs of KU 9 clone (3x) at a rate of 1.64×10^{-3} pink mutant events per hair per R or 2.32×10^{-4} pink mutant cells per hair per cell per R. A D_0 value of 171 R was determined for the terminal meristematic cells of the stamen hairs. This D_0 value was compared with ten other D_0 values obtained earlier from seven different 2x, 4x or 12x clones, and it was reconfirmed that higher radioresistance of higher polyploids is best explained by their smaller chromosome volumes rather than by genetic redundancy. The effects of dose rate on somatic mutation rate and loss of reproductive integrity were also clearly demonstrated. Pink mutant cells were found to have a lower reproductive ability on the average than non-mutant cells. (auth)

48230 EFFECTS OF ACUTE GAMMA RADIATION ON THE SURVIVAL, GROWTH, AND RADIOSENSITIVITY OF THE APICAL MERISTEMS OF CAPSICUM ANNUUM L. AT DIFFERENT STAGES OF SEEDLING DEVELOPMENT. Iqbal, J. (Punjab Univ., Lahore). Radiat. Bot.; 12: No. 3, 197-204(Jul 1972).

Seedlings of Capsicum annuum (long fruited variety) were irradiated with acute γ-rays (^{60}Co) at cotyledonary, 4, 8 and 12-leaf stages of development. Seedlings were exposed to 1, 2, 3, 4, 5, 7.5 and 10 KR. Radio-tolerance of the plant at the different stages of its life history and of its shoot apex was determined. The cotyledonary stage was the most radiosensitive. Sensitivity decreased with increasing age of the plant. Exposures of 3 KR and above were lethal for the seedling growth. In vegetative shoot apices, the central zone was more radiosensitive than the flanks, T-2 more than T-1. Tunica 2 showed maximum sensitivity in floral apices of irradiated plants. Nuclear volume and percentages of cell deaths at different stages of development were important factors in determining radiosensitivity. (auth)

Radiation Effects on Animals (External Source)

Refer also to abstract 50022.

48231 (COO-1653-130) BIOLOGIC CONSIDERATIONS IN ANATOMIC IMAGING WITH RADIONUCLIDES. Progress Report, September 1971–August 1972. Potchen, E. James (Washington Univ., St. Louis, Mo. School of Medicine). 1972. Contract AT-(11-1)-1653. 15p. Dep. NTIS.

Research activities are reported in two major areas: the radioisotopic assessment of microvascular physiology; and the measurement of ventilation using xenon-133. Alterations in the endothelial integrity of the cerebral microvascular system during brain edema are being investigated. In studies of the effects of radiation on tumor microvascular permeability, results indicate that there is a definite effect on the integrity of the endothelial structure, without necessarily being dependent on endothelial cytokinetics. In studies of hepatic radiation injury in rats, a condition involving lesions in the endothelial structure of the central venules, it was found that heparin effectively protected the rats against hepatic injury when administered over a prolonged period of time. A system was developed for measuring human pulmonary ventilation using xenon-133. In the system described, a Pho-gamma III scintillation camera fitted with a diverging collimator is interfaced to a PDP 12 digital computer. The steps involved in data collection, which is under program control, are described. (E.R.B.)

Man

Refer also to abstracts 48207 and 50019.

48232 (ABCC-TR-9-71) RESULTS OF THE FIRST FIVE EXAMINATION CYCLES, 1958–68, HIROSHIMA AND NAGASAKI. Report 5. Belsky, Joseph L.; Tachikawa, Kiyoshi; Jablon, Seymour (Atomic Bomb Casualty Commission, Hiroshima (Japan). Atomic Bomb Casualty Commission, Nagasaki (Japan)). 19 Jul 1971. 177p. (In English and Japanese). Dep. NTIS.

Results are summarized from an epidemiological study conducted from 1958 to 1968 on the incidence of neoplastic and selected non-neoplastic disease conditions in the population of Hiroshima and Nagasaki. No significant differences were found in the health status of lightly irradiated and heavily irradiated atomic bomb survivors and non-irradiated persons, except for diseases of the thyroid and diseases of the eye and no specific dose-response relationship was evident in these cases. Possible evidence of radiation injury was more prevalent in younger female subjects than in other segments of the population. (C.H.)

48233 (ABCC-TR-20-70) DOSE TO THE ACTIVE BONE MARROW, GONADS, AND SKIN FROM ROENTGENOGRAPHY AND FLUOROSCOPY. Antoku, Shigetoshi; Russell, Walter J. (Atomic Bomb Casualty Commission, Hiroshima, Nagasaki (Japan)). 23 Jul 1970. 16p. Dep. NTIS.

Using phantom dosimetry, bone marrow integral, gonadal, and skin doses were calculated for nearly all radiographic and fluoroscopic examinations conducted in the ABCC Department of Radiology. The data are included in tabular form for reference purposes. They will also be used in a continuing investigation of the contribution of medical x ray exposure to the total radiation exposure dose of A-bomb survivors. Results obtained in this study are compared with those published by other investigators. (auth)

48234 (EUR-4830(Vol.2)) PROGRAMME BIOLOGY, HEALTH PROTECTION. Annual Report, 1971. Volume II. (European Communities, Luxembourg. Commission). 480p. (In several languages). Dep. NTIS (U. S. Sales Only). EUR B. Fr. 1,000-(Vol. 1 and 2).

Research programs in the field of radiobiology sponsored by the European Atomic Energy Community (EURATOM) during 1971 are summarized. The studies included: the latent effects of thorotrast on the human hematopoietic system as demonstrated by chromosome aberrations in lymphocytes 20 to 30 years following uptake; the toxicity of ingested tritium in rats; the effectiveness of bone marrow transplants for the treatment of radiation injuries of hematopoietic tissues in man, and related studies in animals; the basic mechanisms of repair of DNA in normal and leukemic cells following exposure to uv radiation and treatment with corticosteroids; and the identification and functional characterization of hematopoietic stem cells using cell cultures and electron microscopy. (C.H.)

48235 (LFEN-130-a) DOSES OF RADIATION IN SPECIAL RADIOLOGICAL EXAMINATIONS. Carreiro, J. Vaz (Junta de Energia Nuclear, Sacavem (Portugal). Laboratorio de Fisica e Engenharia Nucleares). 1972. 20p. (In Portuguese). Dep. NTIS (U. S. Sales Only).

The radiation doses received during medical radiological examinations, especially in cases of aorta-arteriography and phlebography were studied. Thermoluminescent dosimetry was used, with LiF as the thermoluminescent substance. From experiences, the highest radiation doses to various parts of the body, for each type of examination, were determined. From these, the risks to exposed persons were estimated. The meaning of maximum admissible dose is considered in conjunction with the definition of the critical organ, and the values for maximum doses based on these definitions are given. Possible measures for improving conditions of radiation protection for each situation are considered. (E.R.B.)

48236 (ORAU-116) 1971 RESEARCH REPORT FOR THE YEAR ENDING DECEMBER 31, 1971. (Oak Ridge Associated Universities, Inc., Tenn. Medical Div.). 1972. 202p. Dep. NTIS.

Research activities of the Medical Division are reported for the year ending December 31, 1971. Preliminary data are reported for specific investigations in three general areas. Studies on radiation effects and related topics include: clinical total-body irradiation; clinical observations; infections in irradiated patients; dosimetry studies and monitoring; applied radiobiology; and radiation immunology and marrow transplantation. Research in nuclear medicine includes: radiopharmaceutical development; clinical investigations; and computer methods. Basic studies related to radiation, neoplasia, and metabolism include: biochemical studies; marmoset research; ultrastructural studies of tumors; and induced cytogenetic abnormalities. Staff publications, conferences, and seminars are listed for 1971. (E.R.B.)

48237 CODE OF PRACTICE FOR THE PROTECTION OF PERSONS AGAINST IONIZING RADIATIONS ARISING FROM MEDICAL AND DENTAL USE. London; Her Majesty's Stationery Office (1972). 138p. 60 pence.

The code of practice is stated under the headings; scope of the code, general measures for radiological protection, diagnostic use of x-rays, therapeutic use or radiation beams, remotely operated after-loading apparatus and extra-corporeal blood irradiators, therapeutic uses of small sealed radioactive sources, therapeutic and diagnostic uses of unsealed radioactive substances, protection of the patient, patients leaving a hospital after administration of radioactive substances, storage and movement of radioactive substances, and disposal of radioactive waste. Appendices are included that give: responsibility for radiological safety arrangements, maximum permissible doses, maximum permissible body burdens, and maximum permissible concentrations in air and water for radionuclides that are at present in medical and dental use, derived working limits for surface contamination, transfer record for designated persons, symbol to indicate ionizing radiations, tube and source housings, report of the radiotherapy apparatus safety measures panel on requirements for dose control of high energy x-rays and electrons, maximum activities of radionuclides for patients permitted to leave hospital, radiation hazards during the disposal of radioactive corpses, transport of radioactive substances outside hospitals, classification of radionuclides according to relative radiotoxicity per unit activity, definitions of terms, and radiation and contamination monitoring instruments. (UK)

48238 ADEQUACY OF PRESENT STANDARDS OF RADIATION EXPOSURE. Morgan, Karl Z. (Oak Ridge National Lab., Tenn.). Environ. Aff.; 1: No. 1, 91-139(Apr 1971).

The standards for maximum permissible radiation exposure levels for man set by national and international organizations are reviewed. It is pointed out that these levels assume a linear relationship between dose and effect, or that radiation injury is proportional to the accumulated dose and that there is no dose or dose rate so low that the radiation damage is zero. Since natural background radiation is a component of man's environment he has been subjected to radiation damage throughout his existence and any additions to this background radiation level merely increase the probability that man will suffer radiation damage during his lifetime or pass on genetic damage to future generations. General exposures of the human population from man-made sources of ionizing radiation have been very small, with medical diagnostic radiography contributing the greatest exposure. It is pointed out that AEC operations and other nuclear energy facilities are among the safest of all modern industries and the radiation risks to personnel and to the general population are very small. It is concluded that the present radiation protection standards are adequate, but should be kept under constant surveillance by the ICRP, NCRP, and other responsible agencies and all available data on the effects of ionizing radiation should be examined periodically and permissible exposure levels should be adjusted whenever warranted. In evaluating the radiation risks associated with nuclear power production it is pointed out that the risks from the release of sulfur oxides, nitrogen oxides, and hydrocarbons to the environment, should fossil fuel plants be built in lieu of presently planned nuclear power facilities, might be greater than those from ionizing radiation and that the public will gain by eliminating both as environmental pollutants insofar as is practicable. (C.H.)

48239 COMBINED APPLICATION OF HYDROCORTISONE, VITAMINS, AND ANTIBIOTICS IN TREATMENT OF RADIATION-INDUCED INJURIES OF THE RECTUM. Lubenets, E. I. Med. Radiol.; 17: No. 6, 75-9(Jun 1972). (In Russian).

The paper describes treatment of radiation-induced injuries of the rectum by means of presacral injections and intrarectal administration of antiinflammatory preparations stimulating tissue regeneration and of those with analgesic effect (hydrocortisone, vitamin B_{12}, folic acid, antibiotics, novocain, dicaine. A total of 110 patients with late radiation injuries of the rectum have been treated. Ninety-seven patients have been cured, 11 improved, and 2 have had their pains and abdominal discomfort controlled. (auth)

48240 RADIATION MYELOPATHY. Shiozawa, Ryoichi; Yajima, Kazue (Toranomon Hospital, Tokyo). Naika; 28: No. 3, 460-4(Sep 1971). (In Japanese).

The case of a 32-year-old female with radiation myelopathy is reported. X irradiation was carried out to the middle cervical region, in particular, to the sixth cervical spinal cord. The symptoms were evident 11 months after irradiation. They began with the sensory disturbance of the legs, and the motor disturbance appeared gradually. Furthermore the symptoms were progressive. The symptoms corresponding with the disturbance of the sixth cervical spinal cord were conspicuous, following the manifestations like Brown Sequard syndrome in the right side. The deep reflexes of the extremities were increased. The motor reflexes were positive. The spinal fat revealed only a slight increase of protein. No abnormality was found on myelography. From these symptoms, a diagnosis of radiation myelopathy was made because the symptoms were applied to criteria established by Toyokura et al. except Lhemitte's sign. The classification of radiation myelopathy, and the clinical, pathological, pathogenetic studies, and treatment of chronic progressive radiation myelopathy were discussed with reference to current literatures. (Japan)

48241 LIPID AND PROTEIN METABOLISM IN CHRONIC OCCUPATIONAL RADIATION EXPOSURE. Kozlovskii, V. N.; Denisova, E. A. Med. Radiol.; 17: No. 6, 63-7(Jun 1972). (In Russian).

On examination of 181 persons having prolonged contact with sources of penetrating radiation the following changes in the blood serum were detected: an increase of cholesterol by 74.3%; a decrease in lecithin-cholestein index by 59.1%; an increase of B lipoproteins by 71.2%; increased by 58.9% hypoalbuminemia; and an increased by 40% level of α_1, α_2, and γ-globulins. The general protein of almost all the people examined was within the normal limits. With an increase of total radiation dosage the changes in lipid and protein metabolism were observed more frequently and were more marked. These changes are like those in artherosclerotic patients. (auth)

48242 ANTI-RADIATION EYE PROTECTION IN MEGAVOLTAGE RADIOTHERAPY OF MALIGNANT NEOPLASMS. Vorob'ev, Yu. I.; Ibrahim, Omer; El Amin, M. Sc. (Radiation and Isotope Center, Khartoum, Sudan). Med. Radiol.; 17: No. 6, 10-15(Jun 1972). (In Russian).

Attention was drawn to the need for protection of the eye in megavoltage radiotherapy. The measurements were made with a chamber having a sensitive volume of 0.1 cm^3 and 3.5 mm diameter. Lead cylinders with diameter 1 and 1.2 cm and 7 cm long were inserted. Dose distribution was measured beneath the lead shields in the shadowed region. Equations are given for determining the diameter of the lead cylinders according to the size of the area which has to be protected during radiotherapy. (auth)

48243 SMALL INTESTINE INJURIES FOLLOWING IRRADIATION FOR CARCINOMA OF THE CERVIX. Tazaki, Eisei; Ito, Yoshiko (Tokyo Women's Medical Coll.). Sanfujinka Chiryo; 22: No. 6, 634-41(Jun 1971). (In Japanese).

The radiation tolerance of the small intestine and chronic and delayed disturbances after irradiation to the small intestine were described. In addition, several problems concerning the condition of the patient and the techniques of irradiation were discussed as the cause of the delayed disturbance of the small intestine following irradiation for carcinoma of the cervix. Radiotherapy for carcinoma of the cervix is usually carried out by the combination of external x and intracavitary γ irradiation. The relationship between the occurrence of small intestinal injuries and the irradiation method was discussed with reference to literatures. The external irradiation and shielding methods for carcinoma of the cervix were compared with those used for the posterior wall of the urinary bladder, anterior wall of the rectum, and the sacral region. In addition, the wedge filter and the area shielded were described. (Japan)

48244 ANTIBODIES AND IMMUNITY. Nossal, G. J. V. New York; Basic Books, Inc., Publishers (1969). 244p. $5.95.

The subject is discussed under the following headings: antigens; antibodies; evolution of the antibody-forming system; antibody-forming organs of mammals; how the antigenic trigger works; dynamics of antibody production; plasma cells and their properties; immunological memory; immunological tolerance; theories of antibody formation; cellular immune phenomena; genetic principles of transplantation; the wandering lymphocyte; the thymus; immunity and clinical medicine; organ transplantation; allergy and hypersensitivity; autoimmunity; cancer; and irradiation. (E.R.B.)

48245 CONDITION OF THE REGIONAL LYMPH CIRCULATION IN LATE IRRADIATION-INDUCED ULCERS OF THE SKIN (ACCORDING TO LYMPHOGRAPHY DATA). Zedgenidze, G. A.; Bardychev, M. S.; Tsyb, A. F.; Nestaiko, O. V. (Inst. of Medical Radiology, Moscow). Med. Radiol.; 17: No. 6, 3-10(Jun 1972). (In Russian).

Thirty-two patients with late irradiation-induced ulcers underwent direct lower (23) and upper (9) lymphography. Changes of the lymphatic vessels distal to the ulcer consisted in the presence of an irregular lumen, reverse skin flow, and transversely running vessels. Constriction of the major vessels, absence of bulboid dilatation due to the valves, anastomoses of the superficial vessels with the deep ones appear in the zone of irradiation fields. In the area of the immediate localization of the ulcer there is a break of the vessels with formation of contrast pools. The degree of destructive changes in lymphocirculation depended on irradiation dose, the elapse of time after x-ray therapy and duration of the irradiation ulcer. (auth)

48246 RECENT ADVANCES IN NUCLEAR MEDICINE. Lawrence, John H. (ed.). Progress in Atomic Medicine. Volume 3. New York; Grune and Stratton, Inc. (1971). 253p. $15.00.

Separate abstracts were prepared for three of the seven chapters appearing in the book. The other chapters discuss the potential early diagnosis of cancer, the present status of radioiodine therapy of thyroid disease, trace elements in biology and medicine, and heavy-particle therapy of various diseases. (E.R.B.)

For abstracts of individual chapters see: 48184, 48247, and 48280.

48247 SOME CONSIDERATIONS OF PHYSICAL AND BIOLOGICAL FACTORS IN RADIOTHERAPY WITH HIGH-LET RADIATIONS INCLUDING HEAVY PARTICLES, PI MESONS, AND FAST NEUTRONS. Tobias, Cornelius A.; Lyman, John T.; Lawrence, John H. (Univ. of California, Berkeley). Progr. At. Med.; 3: 167-218(1971).

There are a number of factors that favor the consideration of high-LET radiations for radiotherapy. The promise of heavy particles as effective therapeutic agents demands that their properties be further investigated. Some of the biological and physical factors in radiotherapy with high-LET radiations (heavy particles, pi mesons, and fast neutrons) are considered. (E.R.B.)

48248 COMPLICATIONS AFTER RADIATION TREATMENT IN HODGKIN'S DISEASE. Durkovsky, J.; Krajci, M. (Oncological Inst. for Slovakia, Bratislava). Neoplasma; 19: No. 3, 227-33(1972).

Some complications after radiotherapy observed in patients with Hodgkin's disease are reported. There were two cases of a severe postradiation pneumonitis resulting in death, and complications in a group of young patients up to 15 years surviving for a long period of time after the radiotherapy. In these patients development disturbances of the growing thoracic cage, neck vertebral column, as well as radiation damage of muscles, bones, thyroid gland and skin were found. The problem of radiation complications, before all with regard to the technique of segmental radiotherapy, and the problem of radiation complications in patients with Hodgkin's disease at children's age are discussed. (auth)

Vertebrates

Refer also to abstracts 48197, 48202, 48206, and 48215.

48249 (CEA-CONF-1974) BIOLOGICAL EFFECTS OF NEUTRONS IN MAMMALS. Legeay, G.; Lemaire, G. (Commissariat a l'Energie Atomique, Fontenay-aux-Roses (France). Centre d'Etudes Nucleaires). [1971]. 38p. (In French). (CONF-711204-3). Dep. NTIS (U. S. Sales Only).

From Meeting on radiobiological applications of neutron irradiation; Vienna, Austria (6 Dec 1971).

A review of the literature on the biological effects of neutrons on small mammals led to the conclusion that only studies on mice yield precise information on dose distribution and dose response relationships following exposure to fast neutrons or fission neutrons. Studies on rats yielded information on the effects of fission neutrons at various doses on survival, growth, and gonad weight, the latter being an exact method for determining biological response to radiation as a function of time. The data on weigh values for spleen and thymus as a function of dose and time are also meaningful, as is the data on cataract induction in the eyes of rabbits. The need for standardization of neutron sources used for radiobiological studies is stressed. It is pointed out the neutron spectra of various reactors differ greatly. Another need is the development of tissue equivalent small mammal phantoms for use in precise measurements of dose distribution and the relation of Kermo and LET to dose distribution in biological materials. (C.H.)

48250 (COO-1487-7) HISTOPATHOLOGICAL CHANGES IN LABORATORY ANIMALS EXPOSED TO PROTRACTED LOW-LEVEL TOTAL-BODY NEUTRON AND GAMMA RAY FLUXES. A Continuing Study. (Chicago Univ., Ill.). Contract AT(11-1)-1487. 30p. Dep. NTIS.

Studies on mice and other rodents were conducted to establish base lines for future evaluation of exposed animals. Effects of age on the histology of hybrid mice were investigated and histological examinations were made of mice exposed to chronic whole-body low-level doses of gamma radiation or neutrons. Pathological effects of stressful caging were studied and descriptions are given of tumors of various organs and lesions of the lungs, heart, kidneys, stomach, thyroid, adrenal glands, ovaries, pituitary, and mammary glands in non-irradiated animals. (H.L.W.)

48251 (COO-3267-1) RADIATION-INDUCED CHROMOSOMAL INVERSIONS IN MICE. Progress Report, December 1970–May 31, 1972. Roderick, Thomas H. (Jackson Lab., Bar Harbor, Maine). 25 May 1972. Contract AT(11-1)-3267. 36p. Dep. NTIS.

Research objectives are to produce chromosomal inversions by irradiation or chemical treatment of sperm in mice and to detect inversions by observing the frequency of first meiotic anaphase bridges of their sons. Progress is reported on detection of inversions; screening for inversions produced by ethylmethanesulfonate, triethylene melamine, flupromazine, triflupromazine, and radiation; characteristics of inversions; lethality resulting from crossing-over within the inverted segment; and development of a balanced lethal test system. (H.L.W.)

48252 (COO-3267-2) RADIATION-INDUCED CHROMOSOMAL INVERSIONS IN MICE. Comprehensive Progress Report, November 1, 1968–May 31, 1972. Roderick, Thomas H. (Jackson Lab., Bar Harbor, Maine). 25 May 1972. Contract AT(11-1)-3267. 8p. Dep. NTIS.

The production and identification of chromosomal inversions in the testes of mice following exposure to 900 R of x radiation or treatment with triethylene melamine (TEM) were investigated. The rate of induction of inversions showing at least 11% and at least 15% anaphase bridges for mice exposed to x rays was 3.4×10^{-5} per R per gamete (2.8% of the animals screened) and 1.2×10^{-5} per R per gamete (1.0% of the animals screened) respectively. For the TEM-treated mice, the rate was roughly estimated at 6.2% of the animals screened. The linkage groups of some of the inversions were identified by a single backcross of the presumptive heterozygote to a specific strain. One of the inversions that was identified was used to construct a balanced lethal testing stock for identifying and propagating radioinduced recessive lethal mutations. The quinacrine fluorescence technique was perfected for the identification of the linkages of new inversions cytologically. The genetic effects of inversions alone and in combinations were also studied using single and double inversion heterozygotes. (E.R.B.)

48253 (COO-3334-1) THERMAL AND EPITHERMAL NEUTRONS IN THE TREATMENT OF NEOPLASMS. Technical Progress Report, March 1, 1971–April 30, 1972. Sweet, William H. (Massachusetts General Hospital, Boston. Neurosurgical Service). 1 May 1972. Contract AT(11-1)-3334. 26p. Dep. NTIS.

Studies on boron chemistry included the following projects: the utilization of $B_{12}H_{11}OH^{-2}$ as a synthetic intermediate leading to high yield $B_{12}H_{12}^{-2}$ derivatives; the preparation and purification of $B_{12}H_{11}SH^{-2}$ by procedures which would allow the large scale synthesis of this material; and the development of new thin layer chromatography systems for analyzing mixtures of $B_{10}H_{10}^{-2}$ and $B_{12}H_{12}^{-2}$ derivatives. Rats and rabbits were used for evaluation of boron compounds ($Na_2B_{12}H_{11}SH$). Radioautographic studies were conducted for localization of ^{10}B in tissues. Neutron capture therapy experiments were performed on rats containing gliomas; before irradiation each rat received intravenous injections of $Na_2B_{12}H_{11}SH$. Following irradiation observations were made on viability of tumor cells and survival of rats. Other rats with gliomas were x-irradiated for comparative studies on sensitivity of the tumor to neutrons and x rays. Boron-protein studies included developing and testing a variety of methods for binding boron to gamma globulin. Rats bearing astrocytomas were injected with iodine-125-labeled Concanavalin A to determine the extent to which the tumor cells bind Concanavalin A. (H.L.W.)

48254 (NYO-3970-41) CELL PROLIFERATION IN LYMPHOID TISSUE AND THE SEMINIFEROUS EPITHELIUM UNDER CONTINUOUS IRRADIATION. Progress Report, June 1, 1969–May 31, 1970. Fabrikant, Jacob I. (Johns Hopkins Univ., Baltimore, Md. Dept. of Radiological Sciences). 1970. Contract AT(30-1)-3970. 46p. Dep. NTIS.

Both acute and continuous gamma irradiation were used to study the capacity of cell renewal systems to change their patterns of cell proliferation and differentiation under stress. Progress is reported on the following projects: cell proliferation in lymphoid tissue of the normal thymus and spleen; effects of dose rate of continuous irradiation on lymphoid cell proliferation in the thymus and spleen; accumulation of cellular radiation damage in lymphoid tissue under continuous irradiation affecting the regenerative capacity; kinetics of cellular proliferation during radiation lymphomogenesis; cell proliferation in the normal seminiferous epithelium; and cell proliferation in the seminiferous epithelium under continuous low dose gamma irradiation. (H.L.W.)

48255 (ORO-695) ANNUAL PROGRESS REPORT, JANUARY 1–DECEMBER 31, 1971. (UT-AEC Agricultural Research Lab., Oak Ridge, Tenn.). Jul 1972. Contract AT-40-1-GEN-242. 100p. Dep. NTIS.

Progress is reported on the following research projects: effects of radiation on gametogenesis, organogenesis, and growth of the developing mammal; effects of prenatal irradiation on growth; lifetime reproduction herd; fetal physiology and placental transfer; effects of prenatal and early postnatal irradiation of birds; effect of irradiation on the adult bird; late effects of irradiation in large animals; late effects of whole-body gamma irradiation on the work performance and related physiology of Shetland ponies; simulated fallout radiation effects on livestock; radiation effects on mineral metabolism; radioiodine and dairy cattle, diffusion in complex systems; control and modification of seed radiosensitivity; mutation breeding of soybeans; and evaluation of effectiveness, efficiency, and specificity of various mutagenic treatments. (H.L.W.)

48256 (ORO-2903-47) STUDIES IN THE USE OF IONIZING RADIATIONS AS STIMULI. Progress Report, June 1, 1971–June 15, 1972. Smith, James C. (Florida State Univ., Tallahassee. Dept. of Psychology). Contract AT(40-1)-2903. 16p. Dep. NTIS.

In order to test the theory that transmission of a toxic substance by the blood is the basis for radioinduced taste aversion in the rat, 37 pairs of parabiotic rats were used in experiments in which one partner of a parabiotic pair was x or gamma-irradiated and the other partner shielded. The shielded partner was given saccharin to drink shortly after the other partner was exposed. Results indicated that there was no transmission of a toxic substance by the blood. In other experiments lithium chloride and gamma radiation were compared as stimuli for conditioning the taste aversion. The aversion conditioned by lithium chloride was similar to that conditioned by gamma radiation. Although lithium chloride produced sickness in rats, no evidence of sickness was seen in the irradiated rats. (H.L.W.)

48257 (RLO—2225-T-2-3) LOW LEVEL CHRONIC IRRADIATION OF SALMON. Annual Progress Report. Donaldson, Lauren R.; Bonham, Kelshaw; Hershberger, William K. (Washington Univ., Seattle. Coll. of Fisheries). 26 Jun 1972. Contract AT(45-1)-2225. 35p. Dep. NTIS.

Results to date of investigations on the effects of chronic low dose rate irradiation on salmon are presented. In order to determine the effects on survival and growth of adults, eggs and alevins were exposed to γ radiation at dose rates of 2.8, 5.0, 10.0, 20.0, or 50.0 R/day during the period of incubation (71 to 84 days). Following exposure, the young salmon were released along with unirradiated controls. The following year when the adults returned to spawn, their length and weight were measured. These data are presented in tabular form. Delayed genetic effects were determined in the F_1 progeny of the four possible crosses between irradiated and unirradiated males and females. The data available to date is considered as preliminary. (E.R.B.)

48258 (UR—3490-151) ANNUAL REPORT: BRIEF DESCRIPTION OF RESEARCH PAPERS ACCEPTED FOR PUBLICATION DURING 1971. Neuman, William F. (Rochester Univ., N. Y. Atomic Energy Project). 15 Jun 1971. Contract AT(11-1)-3490. 123p. Dep. NTIS.

Abstracts of 163 papers in the field of radiobiology accepted for publication during 1971 are presented. (C.H.)

48259 OCCURRENCE OF MAMMARY TUMORS AND MAMMOTROPIC PITUITARY TUMORS IN RATS TREATED WITH DIETHYLSTILBESTROL OR RADIATION AND IN STOCK RATS. Takizawa, Shoichi; Nishihara, Homi; Kawase, Akira; Yokoro, Kenjiro (Hiroshima Univ.). Hiroshima Daigaku Genbaku Hoshano Igaku Kenkyusho Nenpo; No. 12, 93-105(1971).

Ten female and four male rats were treated with 2 mg of diethylstilbestrol pellet 4 times at intervals of 2 or 3 months. Eight female rats surviving more than 386 days developed both multiple mammary adenocarcinomas and mammotropic pituitary tumors. Concurrence of mammotropic pituitary tumors was observed within 2 years in the 60% of the female rats with mammary tumors, which were exposed to a single total body irradiation with a sublethal dose of ^{60}gamma rays or fast neutrons. In the irradiated male rats, only 6 out of 25 rats developed mammotropic pituitary tumors without accompanying mammary tumor. In the experiment with 380 rads of x-rays, 4 out of 12 female rats developed mammary tumors besides the mammotropic pituitary tumors. Five female rats of Sprague—Dawley strain bore both fibroadenomas of the breast and small mammotropic pituitary tumors at the age of 630 days. In 6 male rats of the same age, no mammary tumor but one case of mammotropic pituitary tumor, and functionally stimulated mammary glands in the rest of the animals were observed. It was suggested that the interaction of carcinogens and mammary gland cells would take place at the initial stage of mammary tumorigenesis, and that the susceptibility to mammary tumor and mammotropic pituitary tumor was genetically determined. (Japan)

48260 TREATMENT OF THE MICE IRRADIATED LETHALLY WITH ^{60}Co γ BY USING THE BONE MARROW TRANSPLANTATION. 2. THE COMBINATION THERAPY OF BONE MARROW TRANSPLANTATION AND CHEMICAL PROTECTIVE AGENTS. Niimi, Masanobu (Hiroshima Univ.). Hiroshima Daigaku Genbaku Hoshano Igaku Kenkyusho Nenpo; No. 12, 238-65(1971). (In Japanese).

Protective effects were observed in mice treated with a chemical radioprotective agent and bone marrow transplants following irradiation to both host (ddN) and donor (CF No. 1). The radiation doses were between 900 and 1,200 R to the host and 100 R to the donor. The death rate due to secondary disease was diminished in 2 to 3 months after the bone marrow transplantation by both the glutathione protection and preirradiation or by only preirradiation to the donor. However, many mice died of the damage to the hematopoietic organs within 4 weeks in spite of these treatments. In the groups irradiated with 1,200 R good survival rates were obtained by the protective method using both serotonin and the allogeneic bone marrow transplantation to the host (ddN). The survival in the groups irradiated with 900 R and protected with both serotonin and allogeneic bone marrow transplantation was higher than that in the group using ddN mice for both host and the donor with irradiation of 900 R. In the experimental groups with glutathione or the similarly systematized groups, the mean number of spleen colonies was 31 or less for every group irradiated with 900 R after protecting with glutathione. It seemed that in the colony forming unit its life was generally damaged by ionizing radiation to the donor mice, and that serotonin could protect this damage as well. (Japan)

48261 QUESTION OF RADIOPROTECTIVE EFFECT OF NON-SPECIFIC IMPULSE AND IMMUNIZATION BY PROTEIN ANTIGEN. Hlavaty, Vlastislav; Zak, Miroslav; Martinek, Jindrich (Charles Univ., Prague). Acta Univ. Carolinae, Med.; 17: No. 3-4, 179-225(1971).

The radioprotective effect of some antigenic non-specific reactions was studied. As possible radioprotective compounds there were used: Betalactin (Spofa), Yatren—Casein (Bayer), Freund adjuvans (Difco) and human serum albumin HSA (home provenance). It was proved that Betalactin and Freund adjuvans if administered 1 × 1 week before irradiation, shows a protective effect in mice that were irradiated with 700 R. Also in repeated administration of HSA before irradiation with 400 and 700 R, a favorable effect on survival of mice is observed. The grade of protection in these compounds is in close relation with the presence of antibodies against applied antigen, with the titre of antibodies, and with the antigenicity of applied compound. The changes in the organism after administration of the above mentioned compounds may be characterized as a great activation of morphological maturation of lymphatic tissue with preserved ability of ICC to form antibodies even after exposure to x irradiation. Also, the differentiation of mezenchymal tissue that causes the production of more resistant forms of cells, plays an important part in protective effects as confirmed by findings of increased activity of mitotic separation of bone marrow cells and corresponding results of these processes in peripheral blood picture. The above mentioned results obtained during application of a non-specific protein antigen may find their practical use as radioprotective compounds if the radiation dose is under the threshold of LD 50/30. The advantage of applied radioprotective compounds is their non-toxicity and long-termed duration of their protective effects. (auth)

48262 EFFECT OF ROENTGEN IRRADIATION ON THE FORMATION OF ENAMEL AND DENTIN IN MAXILLARY RAT INCISORS. Lindvall, Ann-Marie; Omnell, Karl-Ake; Schildt, Bo E. (Univ. of Lund, Malmoe, Sweden. Research Inst. of National Defence, Stockholm). Scand. J. Dent. Res.; 80: No. 3, 253-63(1972).

An investigation of roentgen-ray induced enamel and dentin changes in the maxillary incisor in the rat was undertaken to assess the relative radiosensitivity of amelogenesis and dentinogenesis. Seventy Sprague—Dawley rats received whole body irradiation with exposures between 500 and 950 rad. Five animals served as controls. During the experimental period all the animals were given an injection of oxytetracycline. The animals were killed 5 to 21 d after irradiation. Ground sagittal sections of the incisors were examined microradiographically and with fluorescence microscopy. The irradiation produced elongated external hypoplastic lesions in the enamel and niches in the dentin. The extent of the lesions varied with the radiation dose. The variation in the extent and appearance of the lesions was much greater in the dentin than in the enamel. Even the smallest dose regularly produced changes in the enamel but seldom in the dentin. Amelogenesis thus proved to be more radiosensitive than dentinogenesis. (auth)

48263 CHIMAERISM AND TOLERANCE IN LETHALLY IRRADIATED MICE INJECTED WITH SYNGENEIC AND ALLOGENEIC BONE MARROW CELLS. Stankovic, V.; Boranic, M.; Hrsak, I.; Slijepcevic, M. (Institut Ruder Boskovic, Zagreb). Period. Biol.; 72: 61-9(1970). (In Croatian).

CBA mice were lethally irradiated with 950 R of x-rays, and 4 hours later they were injected with a mixture of bone marrow cells containing allogeneic cells and graded doses of syngeneic cells. The incidence of the lethal secondary disease in these animals, as well as the development of the chimaeric state accompanied with tolerance toward donor-type skin, strongly depended on the number of syngeneic cells in the mixed bone marrow inoculum. (Abstr. Bulg. Sci. Lit., Math., Phys., Astron., Geophys., Geod.)

48264 INTESTINAL FORM OF ACUTE RADIATION SICKNESS SECONDARY TO THE ACTION OF VARIOUS KINDS OF IONIZING RADIATION. Lebedeva, G. A. (Inst. of Biophysics, Moscow). Med. Radiol.; 17: No. 6, 67-72(Jun 1972). (In Russian).

Tests conducted on 10 dogs, 67 albino rats and 40 mice submitted to the action of x rays, mixed gamma-neutron irradiation, α-emitter of ^{210}Po, or β-emitter of ^{144}Ce evidenced that the intestinal form of acute radiation sickness can arise not only under the effect of rays, but also secondary to the action of other types of radiation, including emissions of radioactive isotopes introduced into the organism. The intensity of destructive alterations and the topography of the intestinal lesion vary depending upon the peculiarities specific to the action exercised by each type of radiation. The prerequisite for the development of the intestinal syndrome is the radiation lesion of the small intestine mucosa. At the same time it was found that this form of radiation sickness can emerge as a result of a severe affection of only the distal portion of the small intestine. (auth)

48265 LATENT PERIOD IN LEUKAEMIA INDUCTION BY THE RADIATION LEUKAEMIA VIRUS. Haran-Ghera, N. (Weizmann Inst. of Science, Rehovoth, Israel). Nature (London) New Biol.; 238: No. 79, 21-3(5 Jul 1972).

Radiation leukemia virus (0.1 ml) was injected intraperitoneally into 15 litters of C57BL/6 mice aged 16 hr or less. Cell free extracts were prepared from thymus, spleen, bone marrow, lungs, and kidneys, collected at varying intervals from 10 mice from several litters, and leukemogenic activity evaluated by injecting cell free extract direct into adult thymus glands, and exposing the inoculated mice to 400 R whole-body irradiation. Extracts obtained from thymus glands of 16 day old mice induced leukemia in 100% of inoculated adult mice; that obtained from bone marrow induced leukemia in 45% and extracts from whole blood induced leukemia in 30% of adult mice. On day 21, extracts from lungs, kidney, spleen, bone marrow, and whole blood had a leukemic activity of 35 to 60%, while thymus extract retained its 100% activity. On days 30, 60, and 90, activity was limited to thymus extracts. Results of immunization experiments suggest that within a few months following virus inoculation into newborn mice, these hosts are immunized and capable of preventing leukemic cell proliferation, host resistance disappearing only very shortly before tumor appearance, (between 150 and 190 days). (UK)

48266 IMMUNOLOGIC AND VIROLOGIC PROPERTIES OF CHEMICALLY AND γ-IRRADIATION-INDUCED THYMIC LYMPHOMAS IN MICE. Chan, P. L.; Sinclair, N. R. St. C. (Univ. of Western Ontario, London). J. Nat. Cancer Inst.; 48: No. 6, 1629-40(Jun 1972).

Injecting highly γ-irradiated (3,000 – 120,000 rad), 7,12-dimethylbenz[a]anthracene-induced Swiss thymoma (Sw-DMBA) cells into adult γ-irradiated (700 rad) C57BL/6 mice resulted in 92% incidence of thymomas of host origin. One of these C57BL/6 thymomas (C/Sw-DMBA) was used to induce resistance in Swiss mice to challenge with the original Sw-DMBA thymoma. Nonspecific immunosuppressive substances associated with the ascites form of the Sw-DMBA thymoma were detected by observing 1) a decreased resistance in C57BL/6 mice to syngeneic tumor challenge after attempted immunization with Sw-DMBA and 2) a decreased number of antibody-forming cells produced in an in vitro response to an unrelated antigen when ascitic fluid or sera from Sw-DMBA tumor-bearing animals were introduced into the culture system. Sensitivity to induction of thymic lymphomas after neonatal γ-irradiation (400 rad) was maternally transmitted from the Swiss strain and could be conferred on normally resistant CBA/H mice by injections of highly γ-irradiated (40,000 rad) Sw-DMBA tumor cells. Sensitivity to challenge with Sw-DMBA cells showed the same pattern of maternal inheritance. (auth)

48267 SURVIVAL OF ERYTHROCYTES LABELLED WITH ^{51}Cr FOLLOWING IRRADIATION AND AFTER ADMINISTRATION OF AET. Dienstbier, Z.; Pospisil, J.; Prouza, Z. Bratislav. Lek. Listy; 56: No. 4, 385-90(Oct 1971). (In Czech).

Studies were conducted on the influence of the radioprotective substance AET on the half-life survival of erythrocytes of rats exposed to whole-body x radiation. It was found that the half-life was increased by AET. (H.L.W.)

48268 INVESTIGATION OF THE MACROMOLECULAR STRUCTURE OF BRAIN DNA IN IRRADIATED ANIMALS. Kakuliya, M. E.; Vatsadze, G. S. (Inst. of Physiology, Tbilisi, USSR). Neuropatol. Pol.; 7: No. 3, 377-84(1969).

Rabbits were given a single 700 R dose of x radiation and were decapitated 10 min later. Products of degradation of DNA by acid DNA-ase were determined by spectrophotometry. In other experiments the head only was given a 9000 R dose of x radiation and whole-body irradiation was applied in doses of 50 to 9000 R. The brain was removed at intervals of 2 to 90 min, 3 to 19 hrs, and up to 1.5 months. Samples of gray and white matter were analyzed separately and molecular melting profiles of DNA and DNP were obtained. Following whole-body radiation very little repair of radiation injuries was noted. Repair was found to be more complete in grey than in white matter. It is suggested that structural changes of DNA in white matter may be related to injury of the glia, especially the oligodendroglia. (H.L.W.)

48269 PATHOLOGICAL CHANGES OF ULTRASTRUCTURES OF HEPATOCYTES OF AXOLOTLS AFTER X IRRADIATION. Turska, R. (Coll. of Agriculture, Wroclaw). Zool. Pol.; 21: 91-6(1971).

It was observed that hepatocytes were not all equally sensitive to x radiation; electron microscopy revealed normal cells as well as those with pathological changes. A single dose of 1200 R caused a concentration of osmophilic substance in the periphery of the nuclei, swelling of the mitochondria, and vacuolization of the endoplasmic reticulum. Furthermore, negligible numbers of ribosomes and a marked increase in the lipid content were found. In some cells numerous myelin figures were observed. (NSA of Poland)

48270 INFLUENCE OF IRRADIATION IN VIVO ON OXYGEN CONSUMPTION AND RESPIRATORY CONTROL OF ISOLATED RAT-LIVER CELLS. Watras, J.; Widel, M. (Inst. of Oncology, Gliwice, Poland). Neoplasma; 19: No. 3, 175-9(1972).

The oxygen consumption and respiratory control of isolated liver cells of rats irradiated with 1000 R on the whole body were studied. The polarographic measurements performed 24, 48 and 72 hours after irradiation have shown no significant changes (except endogenous respiration after 24 hours) on oxygen consumption or respiratory control of isolated cells. The obtained results support Thomson's opinion that the uncoupling of oxidative phosphorylation of liver mitochondria 24 hours after irradiation reported by several authors might be an artefact connected with mitochondrial damage during their isolation. (auth)

48271 INVESTIGATIONS CONCERNING THE INCREASE OF THE RADIATION-PROTECTIVE EFFECT OF ANABOLIC STEROIDS. Panek, R. (Medizinische Akademie, Bialystok, Poland). Strahlentherapie; 143: No. 5, 559-69(May 1972). (In German).

Examinations were performed with regard to the possibility to intensify a radiation-protective efficacy through combination of anabolic steroids (Dianabol) with already known radiation-protective substances, with different site and mode of action, on the survival rate and hematological changes. The tests were carried out in five independent series on 1260 Wistar rats. It was found that the tested substances and their combinations had no toxic effect on the experimental animals. The median LD_{50} of x rays in the various test series amounted to 450 ± 80 R. Each of the tested substances, separately applied, showed a certain radiation-protective effect; the dose reduction factor (DRF) of the most effective substances amounted to 1.44 for Dianabol, for Mexamine to 1.65, for Cysteamine to 1.58, and for DNA to 1.61. By combined appliance of the substance tested, better radiation-protective effects were obtained; thereby the appliance of compounds inhibiting the release of free radicals (as do the hydroxyl or nitryl group) as well as restitutive substances together with Dianabol proved to be most effective. The corresponding dose reduction factor for the combinations of Dianabol with hydroxyl, nitryl or DNA amounted to 1.88, 1.77, and 1.88. The highest DRF of 2.70 was obtained in the experimental animals by combining DNA, hydroxyl groups, and cerium with Dianabol. The relatively lowest radiation-protective action was found when using Dianabol combined with the inhibitors of proteolytic enzymes (Iniprol, PAMBA). In the interpretation of hematologic tests, only the combination of Dianabol with hydroxyl and nitryl groups and DNA had a better radiation-protective effect. The tests showed that the short-acting radiation-protective substances applied give better results in case of radiation sensitivity altered through long-term therapy with Dianabol. (auth)

48272 INFLUENCE OF UNILATERAL LOSS OF A KIDNEY ON THE FUNCTION OF THE IRRADIATED RESIDUAL KIDNEY. Bargon, G.; Rittmeyer, K. (Medizische Hochschule, Hanover. Univ., Goettingen, Ger.). Strahlentherapie; 143: No. 5, 540-8 (May 1972). (In German).

On 400 male wistar rats, divided in five groups, the morphological and functional changes following a single homogeneous irradiation with 3000 rads were investigated. The renal function was studied in the Warburg apparatus on sections of survivant renal cortex. The changes in the irradiated kidneys of animals, which had two healthy organs before the exposure, were compared to those of animals, whose contralateral kidney had been extirpated two or 63 days before irradiation. In the irradiated kidney of animals with both organs, already 21 days after exposure a drop of the renal function to two thirds of the initial value had occurred, subsequently followed by a slight recovery of the function up to the 63rd day after irradiation. The morphological changes (adhesions of malpighian loops and nuclear damages on the glomerulus, necroses of the tubulus cells, loss of epithelia, and nuclear lesions) were very distinct already on the 21st day after exposure; in relation to the temporal distance from the radiation exposure, the changes increased. In contrast to this, the operative loss of one kidney, two days before irradiation of the residual kidney, led still on the 21st day after exposure to an increase of the tubular function in the radiation-injured organ, later on followed by a greater loss of function. In the kidney hypertrophic already before the beginning of the irradiation, no functional rise was observed after exposure. The functional loss 21 days after exposure was not yet so significant as in the irradiated kidney of the animals with healthy second kidney, yet there was no subsequent recovery of the functional capacity, but a slowly progressive decrease. The compensatory-hypertrophic growth stimulus after unilateral loss of a kidney caused an increased epithelium regeneration in the tubuli of the residual kidney irradiated with 3000 rads, producing pathological types of cells. These pathological cellular regeneration products were lacking in the specific function of normal cells of the tubulus epithelium. Therefore, they do not mean a functional profit for the radiation-injured kidney with compensatory hypertrophy. (auth)

48273 DOSE-RATE AND MUTATION FREQUENCY AFTER IRRADIATION OF MOUSE SPERMATOGONIA. Lyon, M. F.; Papworth, D. G.; Phillips, R. J. S. (Medical Research Council, Harwell, Eng.). Nature (London) New Biol.; 238: No. 82, 101-4(26 Jul 1972).

The relationship between dose-rate and postirradiation mutation frequency in mouse spermatogonia is considered with regard to the relevant published and some unpublished data. Consideration is given to: reinterpretation of the data to show that the form of relationship between mutation rate and dose-rate is similar to that for translocations; and testing the apparent inverse relationship of mutation rate and dose range over ranges 0.001R/min to 0.009R/min. A quadratic relationship is derived between induced mutation rate/R/locus and $\log_e I$, where I is the dose-rate in R/min. It is pointed out that such a relationship is possible if it is supposed that repair is dependent on dose-rate. If there were two mechanisms, it might be that the position of I_{min} is such that at dose-rate below I_{min}, the period of irradiation necessary to give the total dose must extend over many cell cycles, giving scope for a change in the structure of the cell population during irradiation. Also, the effect of radiation in cells may change with dose-rate. Thus, killing of spermatogonia might cause differential elimination of mutated cells, or make the surviving cell population less sensitive. (UK)

Invertebrates

48274 SEX PHEROMONE PRODUCTION AND REPRODUCTIVE BEHAVIOR IN GAMMA-IRRADIATED TENEBRIO MOLITOR. Menon, Maya; Nair, K. K. (Simon Fraser Univ., Burnaby, B. C.). J. Insect. Physiol.; 18: 1323-31(1972).

Studies to determine the effects of gamma-radiation on sex pheromone production in female Tenebrio molitor showed that irradiation of females either as newly emerged or as pharate adults with 3.5 or 7 krad had no significant effect on their sex pheromone activity when compared to that of normals. However, treatment of irradiated insects with a juvenile hormone analogue increased their pheromone activity, whereas it decreased the pheromone activity in the normals. Ovary maturation was inhibited in irradiated insects, and it could not be alleviated by treatment with juvenile hormone analogue. Since ovarian transplants from normal to irradiated insects showed yolk deposition, whereas reciprocal transplants did not, it is concluded that the inhibition in yolk deposition in the ovaries of irradiated insects was due to radiation damage to the ovary itself rather than to the neuroendocrine system. Irradiation of the males with 7 krad did not affect their ability to respond to the female sex pheromone or their sexual vigor. At higher doses, their response was slow and it decreased with increase in radiation dose, and also as a function of time after irradiation. (auth)

48275 INDUCTION OF CHROMOSOME MUTATIONS BY X-IRRADIATION IN TETRANYCHUS URTICAE (TETRANYCHIDAE) WITH RESPECT TO A POSSIBLE METHOD OF GENETIC CONTROL. Van Zon, A. Q.; Overmeer, W. P. J. (Univ. of Amsterdam). Entomol. Exp. Appl.; 15: No. 2, 195-202(1972).

Searching for a method of genetic control to eradicate spider mite populations in glasshouses, the possibility of establishing reproductive incompatibility between a mother colony of Tetranychus urticae Koch and derivative subcolonies, due to the induction of chromosome mutations, was investigated. If it is possible to build up complete reproductive incompatibility, males of the chromosome mutation strains can be used to control the original population. It appeared that x-irradiation at a dosage of 2250 R induced a considerable number of chromosome mutations in the sperm of T. urticae. Some of these chromosome mutations were made homozygous, by following a particular crossing-scheme. In this way thirteen different chromosome mutation strains were established. When outcrossing these strains to the original colony the degree of mortality in the haploid F_2 ranged from 53.4 to 92.8%. After outcrossing the various chromosome mutation strains to each other the degree of mortality in the haploid F_2 was between 61.6 and 99.8%. These findings show that in some cases induction of two different chromosome mutations can result in nearly complete reproductive incompatibility. It is not known what sort of chromosome mutations were involved. (auth)

48276 EFFECTS OF IONIZING RADIATION AND TEMPERATURE ON THE LARVAE OF THE PACIFIC OYSTER, CRASSOSTREA GIGAS. Nelson, Victor Avery. Seattle; Univ. of Washington (1972). 88p. University Microfilms Order No. 72-20,881.

Thesis.

Chronic irradiation began with the addition of zinc-65(^{65}Zn) or tritium (^{3}H) to the rearing water when the oysters were in the gamete, zygote, 2-cell, or rotating blastula stage and continued until 48 hours after fertilization. Embryos in the zygote stage also were exposed to acute machine-produced x-ray doses of 0.8 to 100 roentgens (R). In another experiment, 24 hour old larvae were exposed for 10 to 15 seconds to water temperatures ranging from 32 to 50°C, after which the water temperature was lowered to the initial rearing temperature. All of the groups exposed to radiation and thermal stress were reared at water temperatures of 20, 24, or 28°C for 48 hours after fertilization. The criteria used to measure stress effects were rate of development, incidence of abnormal larvae 48 hours after fertilization, and survival at 48 hours. Statistically significant increases in the number of abnormal larvae were observed at concentrations of 10^{-4} curies (Ci) of ^{65}Zn per liter and 10^{-3} Ci of ^{3}H per liter. These concentrations gave a dose of about three-fourths of a rad to the larvae in 48 hours. An x-ray dose of 8 R produced similar increases in abnormal larvae. Radiation did not affect the rate of development or survival during the 48-hour period of these experiments, and no significant differences in radiosensitivity relative to stage of development at the time of irradiation were evident. An increase in rearing temperature of 8°C to a temperature of 28°C increased the incidence of abnormal larvae. Embryos in the zygote stage that were exposed for about 15 seconds to water temperatures of 36°C or greater (Δt_3's of 16, 12, and 8°C above ambient rearing temperatures of 20, 24, and 28°C, respectively) showed a significant delay in the rate of development, an increase in the frequency of abnormal larvae, and an increase in mortality. Acute exposure of zygotes to a temperature of 32°C (a Δt_3 of 12°C ambient) resulted in a decrease in survival for larvae reared at 20°C. Acute exposure of 24-hour larvae to temperatures of 45 and 50°C for larvae reared at 20°C before and after the exposure produced significant increases in the incidence of abnormal larvae and in larval mortality. No increases in abnormal larvae or mortality were attributed to acute exposure of 24-hour larvae to temperatures of up to 50°C (22°C Δt_3) when the larvae were reared at 28°C. The interaction effects of radiation and rearing temperature were independent. From a comparison of the results of these experiments in regard to the effects of radiation, temperature, and radiation-temperature with those of environmental conditions now present or predicted for the future from the normal operation of a nuclear reactor, it is concluded that radiation has not caused and would not cause detectable effects on the gametes, embryos or larvae of the Pacific oyster; and chronic exposures to temperatures above 28°C or acute exposures above 32°C would result in a significant increase in larval mortality. (Diss. Abstr. Int., B)

Radionuclide Effects (Internal Source)

Refer also to abstract 47973.

Man

Refer also to abstract 48238.

48277 HEMOGLOBIN OF THE RED CELL STROMA FROM MINERS OF URANIUM. Nosek, J.; Pehr, F. Cas. Lek. Cesk.; 110: No. 51, 1185-8(17 Dec 1971). (In Czech).

The assessment of hemoglobin in stromas of red blood cells is described. In miners of deep uranium mines, as much as 16% more bound hemoglobin was found in red cell stromas, if the mean content of hemoglobin in red cell stromas of controls is taken as 100%. The finding of a higher hemoglobin content in red cell stromas was compared with the change of the average rate of turnover of methemoglobin in vitro in red cell suspensions. The increase of the bound hemoglobin content in red cell stromas of miners is a process that develops gradually and culminates at a time of the maximum turnover of methemoglobin in red cell suspensions in vitro. With the gradually declining rate of methemoglobin turnover in red cells, declines also the amount of bound hemoglobin in stromas and the amount of polarographically active sulphhydryl groups in hemolysates. The maximum increase of bound hemoglobin stromas in red cells in miners occurs after 5.5 yrs' work in this occupation. (auth)

48278 CASE OF FETAL EXPOSURE TO ^{131}I. Hara, Masao (Niigata Univ., Japan). Rinsho Hoshasen; 17: No. 1, 71-4(Jan 1972). (In Japanese).

A woman was treated with ^{131}I for Basedow's disease at a very early stage of pregnancy and in the 5th pregnant month. She delivered a male baby one month earlier than expected. He was a premature baby weighing about 1860 g at birth and had a feeble vitality. His growth was poor and contracted otitis media at age 2 and pneumonia at 5. Findings at age 14 showed a height of 137.5 cm and a body weight of 36 kg, with no physical finding suggestive of anomalies of the thyroid function. Thyroid function tests revealed the basic metabolism rate (BMR) to be +4%, ^{131}I$-$T$_3$ uptake to be 26.5%, ^{131}I uptake rate by the thyroid to be 23.8%, serum total cholesterol to be 135 mg/ml, and LDH to be 255 units/ml, all being normal. The mother's thyroid function was normalized later and delivered normal female and male babies. The literature was examined in regard to 14 cases of fetal exposure to ^{131}I. (Japan)

48279 RADIATION LOADS OF CRITICAL ORGANS IN SOME RADIODIAGNOSTIC INVESTIGATIONS. Mirkhodzhaev, A. Kh. Med. Radiol.; 17: No. 6, 53-6(Jun 1972). (In Russian).

On the basis of kinetic data, radiation loads were determined by using different labeled compounds. It was established that the dose absorbed by the critical organ when I mc of rose bengal labeled with ^{131}I was used averaged 0.3 and 3 rads respectively, I mc of colloid particles labeled with ^{99m}Tc and ^{198}Au—1.7 and 35 rads; I mc of denaturated albumin labeled with ^{125}I and ^{131}I—0.13 and 1.6 rads I mc of serum albumin labeled with ^{99m}Tc, ^{51}Cr; ^{125}I and ^{131}I—0.01, 0.16, 0.45 and 1.7 rads. (auth)

48280 SAFE TRACER DOSE IN MEDICAL INVESTIGATION. Saenger, Eugene L.; Kereiakes, James G. (Univ. of Cincinnati). Progr. At. Med.; 3: 139-65(1971).

The in vivo use of compounds labeled with radioactive nuclides has greatly widened the horizons of investigators engaged in research involving human beings. It is possible to take advantage of extremely delicate and sensitive methods, hitherto unavailable, since one can now label almost all compounds and tissues in the body either by the introduction of the compound itself or by a precursor. In this discussion we shall not focus on the scientific value of these varied techniques but rather on their inherent safety and also on the acceptability of administering radioactive materials to human beings in this interesting decade of scientific development and public interest. There are four essential aspects to the determination of safe tracer doses to be presented here. These are: 1. Limitations imposed by current attitudes in regard to the broad aspects of human investigation. 2. The scientific evidence in regard to radiation effects in human beings. 3. The derivation of acceptable rules of administration of labeled compounds for adults and children that can be utilized by the clinical investigator. 4. Guides for calculation of doses for various age groups, body sizes, and labeled compounds of particular biological interest. (auth)

Animals

Refer also to abstracts 48264 and 48276.

48281 (BNWL-SA-4245) LATE EFFECTS OF CHRONIC ^{90}Sr INGESTION IN MINIATURE SWINE. Ragan, H. A.; Buschbom, R. L.; Clarke, W. J.; Hackett, P. L.; McClanahan, B. J. (Battelle Pacific Northwest Labs., Richland, Wash.). 1971. Contract AT(45-1)-1830. 10p. (CONF-720818-1). Dep. NTIS.

From second international conference on strontium metabolism; Glasgow and Strontian, Scotland (16 Aug 1972).

Strontium-90 was fed daily to female miniature swine and they were subsequently bred to control males. Animals in the F$_2$ generation were treated in the same way. Over the past 14 years, over 700 miniature swine, representing 3 generations, have been exposed to daily ^{90}Sr-ingestion at 1 to 3100 μCi. Results are presented with regard to dose rates to skeleton, life span, farrowing performance, osseous lesions, hematopoietic effects, and development of neoplasms. (H.L.W.)

48282 (UCRL-Trans-1462) RADIORESISTANCE AND RADIOSENSITIVITY OF ANIMALS TO EXPOSURE TO TRANSURANIUM ELEMENTS. Moskalev, Yu. I.; Zalikin, G. A.; Petrovich, I. K.; Rudnitskaya, E. I.; Veselovskaya. Translated for Univ. of California, Lawrence Berkeley Lab., Berkeley, from pp 76-8 of Radiatsiya i Organizm. Sbornik Material ov Konferentsii, Volume 1, Obinsk, 1967. 3p. Dep. NTIS.

Study of the biological action of transuranium elements conducted on a comparative plane makes it possible to distribute them in groups by their biological action. Uranium and neptunium prove to be similar. Either isotope affects the animal organism with the combined action of a chemical agent and a radioactive substance. At early observational periods, of animals exposed to neptunium-237, the toxic effect predominates, while at later periods the radioactive substance has a stronger effect. Americium-241 is closer in its action to plutonium-239: in early observational periods it is found in a finely-dispersed state in all tissues of the organism with predominantly uniform distribution therein and with accumulation in the liver. Later it is redistributed in the bones. Each of these isotopes has its specific features. (auth)

48283 VLIYANIE INKORPORIROVANNYKH RADIOIZOTOPOV NA IMMUNOLOGICHESKIE PROTSESSY. (Effect of Incorporated Radioisotopes in Immunological Processes). Nevstrueva, M. A.; Shubik, V. M.; Tokin, I. B. Moscow; Atomizdat (1972). 192p.

This monograph discusses the relation of radioisotopes to immunological processes in animal organisms, both anti-microbe resistance and the formation of antibodies in the irradiated organism. Experiments on the whole organism, and at the cellular and subcellular level were conducted. The formation of antibodies was studied for internal irradiation from ^{137}Cs, ^{90}Sr, ^{144}CE, ^{131}I, and fission product mixtures. (449 references.) (K.S.W.)

Microorganisms

48284 BIOLOGICAL AND PHYSICAL EFFECTS OF RADIOPHOSPHORUS DECAY IN BACTERIOPHAGE T4D. Levy, Jack Norman. Seattle; Univ. of Washington (1972). 181p. University Microfilms Order No. 72-20,874.

Thesis.

The decay of radiophosphorus which has been incorporated into the DNA of bacteriophage T4D creates damages which alter the biological properties of this virus and the physical structure of its DNA. When ^{32}P-T4D is stored in buffer at 4°C lethal damages and double strand breaks in the DNA accumulate at the rate of 0.10 per decay. When phage is stored at 4°C in buffer supplemented with 2.8% AET, lethal damages and double strand breaks accumulate at the rate of 0.05 per decay. The concomitant reduction of lethal damages and double strand breaks implies that double strand breaks are the lethal damage. Single strand breaks form at the rate of one per decay when ^{32}P T4D is stored in buffer at 4°C. The excess of single strand breaks over lethal damages implies that single strand breaks can be repaired during infection. The genetic structure of these damages was studied by marker rescue. The efficiency of marker rescue from T4D inactivated by ^{32}P decay varies from region to region. The topology of rescue is similar to that previously observed using phage inactivated by uv- or x-irradiation. The possibility that this topology is due to the combined effect of partial injection failure and non-random injection origins has been eliminated. The size of genetic damages in individual ^{32}P-inactivated T4D particles has been determined. About half of the lethal damages completely destroy the ability of the irradiated phage to contribute genetic information during mixed infection with a genetically distinct and active phage. The remainder of the damages inactivate only part of the genome. The inactivated portion (or knockout) can be as small as 1% of the genome or as large as 99%, and averages 17% at low dose. A single inactivated phage may have as many as eight knockouts; thus not all knockouts are the result of partial injection failures. (Diss. Abstr. Int., B)

Nuclide Kinetics and Toxicology

Man

48285 (NP-19358) ^{226}Ra IN MAN. Beninson, D.; de Beninson, A. M.; Menossi, C. (Comision Nacional de Energia Atomica, Buenos Aires (Argentina). Division Estudios Ambientales). 1972. 21p. (In Spanish). (RS-35/67). Dep. NTIS (U. S. Sales Only).

The purpose of this study was to derive parameters for describing the metabolism of radium and to make use of methods for estimating the dose commitments in human bone, in view of the presence of this radioelement in the diet. Also, based on a similiar study made on radiostrontium, the behavior of this important alkaline-earth element was determined in order to understand its metabolic parameters in the skeleton. The basis of this study was the deduction of transfer parameters based on measurements of ^{226}Ra and stable Ca contained in the diet and in bone samples obtained at autopsy. Such a study naturally has necessary restrictions related to the representative samples and to the uncertainties associated with the various suppositions that have been made. However, advantage was taken in the physiology and radiotoxicology studies of real cases of ambient contamination. (tr-auth)

Animals

Refer also to abstracts 48049, 48054, 48255, 48258, and 48282.

48286 (AED-C-21-9) BIBLIOGRAPHIES IN NUCLEAR SCIENCE AND TECHNOLOGY. Section 21: Dosimetry. Becker, Klaus (comp.) (Zentralstelle fuer Atomkernenergie-Dokumentation, Frankfurt am Main (West Germany)). Apr 1972. 199p. (In German and English). Dep. NTIS (U. S. Sales Only).

Some 2,000 references to the world literature on the uptake, tissue distribution, and internal radiation dose from various radioisotopes in animals are presented. Author and subject indexes are included. (C.H.)

48287 (BNWL-1657) METAL-DTPA CHELATES IN BIOLOGICAL SYSTEMS: A BIBLIOGRAPHY. Smith, V. H. (Battelle Pacific Northwest Labs., Richland, Wash.). Apr 1972. Contract AT(45-1)-1830. 52p. Dep. NTIS.

The purpose of this bibliography is to point out the diversity of metals that have been used in biological systems involving the chelon, diethylenetriaminepentaacetic acid (DTPA). Literature has been surveyed up through August, 1971, but no claim to completeness is made and the author would appreciate missing entries being brought to his attention so that the listings can be made more complete and brought up to date. The bibliography is arranged alphabetically by elements, chronically within such divisions and alphabetically within the time periods. Papers dealing with more than one element were entered under each element. (auth)

48288 (COO-2044-5) ^{210}PoO$_2$ METABOLISM IN RUMINANTS. Final Report and Summary, 1969-1972. Johnson, James E.; Watters, R. L. (Colorado State Univ., Fort Collins). 30 May 1972. Contract AT(11-1)-2044. 67p. Dep. NTIS.

A significant fraction of ^{210}PoO$_2$ ingested by ruminants is absorbed from the gastrointestinal tract and secreted into milk. The average milk transfer coefficient observed for cows was 0.012% (percent intake secreted per liter per day). This is nearly 25% of the value observed for fallout ^{137}Cs. The average transfer coefficient observed in the goat was 0.45. The ratio of transfer coefficients for the cow to that for the goat is very nearly the same as observed for ^{137}Cs. Apparently plant uptake of ^{210}Po does not produce any modification of the chemical form that allows greater gut absorption in the ruminant. The tissues of greatest concentration of ^{210}Po in the ruminant were the kidney, spleen, adrenal gland, mammary gland and hair. Parameters derived from acute ingestion experiments have been shown to be useful in the prediction of equilibrium levels in animals grazing continuously on pasture contaminated by an acute radionuclide dispersal. The resulting equations can be used to derive an estimate of the body burden in a population whose sole source of milk comes directly from contaminated pasture. Calculations indicate that the maximum pasture surface contamination of ^{210}PoO$_2$ that would produce the maximum permissible body burden (MPBB) to the general population as defined by the ICRP would correspond to an average surface concentration of 0.49 μCi/m^2 for cows and a minimum intake on the first day following deposition of the ^{210}PoO$_2$ on the pasture surface of 22 μCi. This means that the accidental release of 1 megacurie of ^{210}Po over a milkshed having an area of less than 130,000 sq. miles (an area approximately the same as the entire country of Finland and only slightly less than the area of Japan) assuming an even distribution over the entire pasture surface, could result in a MPBB for the public drinking cow's milk. A very important conclusion was obtained from the experiments comparing the gut absorption of ^{210}Po in rats drinking either ^{210}PoO$_2$ in water or as secreted into milk. The gut absorption of the ^{210}Po from the milk was 20 times greater than from ^{210}PoO$_2$ in water. Apparently a modification of the chemical form occurred which enhanced the absorption to considerably greater values than accepted by the ICRP. This implies that the calculation of the food chain hazard would underestimate possible doses to humans due to pasture surface contamination. (auth)

48289 (RLO-2225-T-1-10) COLUMBIA RIVER STUDIES. Annual Progress Report, 1971-1972. (Washington Univ., Seattle. Lab. of Radiation Ecology). 23 Jun 1972. Contract AT(45-1)-2225. 33p. Dep. NTIS.

Progress is reported on the following studies on the Columbia River: monitoring of ^{65}Zn in mussels; measurement of background radiation to oysters and in bottom sediments with thermoluminescent dosimeters; cycling of radionuclides in a simple marine ecosystem; and biological half-life studies on ^{65}Zn in oysters and ^{59}Fe in rainbow trout. Appendices are included that report results of studies on the decline of ^{65}Zn in marine mussels following the shutdown of Hanford reactors; and ^{59}Fe content of organs of trout following subcutaneous injection. (H.L.W.)

48290 SODIUM ALGINATE IN BREAD INCREASES THE CONCENTRATION OF ^{85}Sr IN BLOOD OF MICE WITH AN OLD ^{85}Sr CONTAMINATION. van der Borght, O.; Keslev, D.; van Puymbroeck, S. (SCK/CEN, Mol, Belgium). Environ. Physiol.; 1: No. 3, 119-21(1971).

Sodium alginate incorporated in bread and fed to mice with a 3-week old ^{85}Sr-contamination given by intraperitoneal injection, induced an increase in the ^{85}Sr-concentration in blood. Controls received the same bread in which agar replaced the alginate. Fecal excretion was enhanced but urinary loss of ^{85}Sr was less in the mice on the alginate diet. (auth)

48291 KINETICS OF THE DIRECT UPTAKE OF Ca AND Sr IONS FROM WATER BY FRESHWATER GASTROPODS. van der Borght, O.; van Puymbroeck, S. (SCK/CEN, Mol, Belgium). Environ. Physiol.; 1: No. 2, 83-95(1971).

Direct uptake of ionic calcium and strontium from the water occurs in some freshwater snails (Gastropoda, Mollusca). Temperature influences principally the influx rates, whereas outflux is less effected by changes in temperature. The increase of influx rate of ^{45}Ca and ^{85}Sr with increasing temperature did not follow the Arrhenius law and therefore does not correspond with a simple enzymatic process. Existence of at least two Ca-exchanging compartments in the animals is suggested by compartmental analysis of ^{45}Ca absorption and by the exchange of Ca in ^{45}Ca loaded animals when they are submitted to a sudden decrease in temperature. Between the experimental limits (6° to 30°), the observed ratio for the absorption of Ca and Sr is independent of temperature, and varies between 0.3 and 0.6. (auth)

48292 EFFECTS OF HEAVY METALS ON RENAL ASPARTATE TRANSPORT AND THE NATURE OF SOLUTE MOVEMENT IN KIDNEY CORTEX SLICES. Foulkes, E. C. (Univ. of Cincinnati). Biochim. Biophys. Acta; 241: 815-22(14 Sep 1971).

Effects of uranium poisoning and of p-chloromercuribenzoate (PCMB) on renal amino acid transport in the rabbit are explored. Characteristics of translocation of amino acids as well as of sugars are compared in vitro (cortical slices) and in vivo (double indicator dilution analysis of artery-to-vein transit kinetics, clearance studies) in order to evaluate the physiological significance of slice studies. Dicarboxylic amino acids interact with the peritubular cell membrane in vivo by a specific mechanism which is sensitive to uranyl ions and PCMB. However, PCMB fails to depress tubular reabsorption of filtered aspartate; this makes it unlikely that the PCMB-sensitive process at peritubular cell membrane can form part of the reabsorptive process. Aspartate uptake in vitro is inhibited by PCMB. It follows that uptake of aspartate by slices is a function of peritubular cell membrane, and not of the PCMB-sensitive reabsorptive mechanism. Evidence is also presented for the occurrence of sugar transport across peritubular cell membrane in vivo. The specificity of this transport resembles that described for sugar uptake by slices. Activity at the peritubular membrane may suffice therefore to account for sugar accumulation in vitro. As suggested previously there is thus no need to invoke participation of luminal cell membranes in solute transfer by kidney cortex slices. (auth)

48293 INFLUENCE OF CASTRATION ON SEXUAL DIFFERENCES IN ^{131}I UPTAKE BY THYROID AND SUBMANDIBULAR GLANDS IN MICE. Houssay, Alberto B.; Bozzolo, Eduardo; Curbelo, Halina M. (Univ., Buenos Aires). J. Dent. Res.; 51: No. 4, 1005-9(1972).

In A$_2$G mice, the ^{131}I submandibular gland-plasma ratios were higher in males than in castrated males and higher in castrated males than in females. The ^{131}I thyroid gland uptake was greater in females and castrated males than in males. The submandibular gland ^{131}I uptake curve had its peak four hrs after the tracer dose was administered. (auth)

48294 EFFECT OF FLUORIDE-CONTAINING COMPOUNDS ON THE SKELETAL RETENTION OF ^{89}Sr AND ^{45}Ca IN THE RAT. Light, James M.; Stookey, George K. (Indiana Univ., Indianapolis). J. Dent. Res.; 51: No. 4, 909-17(1972).

A series of three studies was conducted with rats to investigate the influence of various means of fluoride supplementation on radioactive strontium metabolism. The data demonstrated that shortened periods of fluoride exposure of 60 days or less did not alter radioactive strontium metabolism appreciably, but periods of fluoride exposure of four to eight months decreased the skeletal retention of radioactive strontium significantly. (auth)

48295 METHOD FOR THE SIMULTANEOUS MEASUREMENT OF ^{67}Ga, ^{111}In, AND ^{75}Se IN TUMORS USING A SEMICONDUCTOR DETECTOR. Higasi, T.; Kanno, M.; Kurihara, H.; Mindelzun, R. E. (Kanagawa Dental Coll., Yukosuka, Japan). J. Nucl. Med.; 13: No. 8, 624-6(Aug 1972).

The use of a Ge(Li) semiconductor detector made it possible to detect uptakes of ^{67}Ga-citrate, ^{111}In-chloride, and ^{75}Se-selenite in the same tumor-bearing mice at the same time. The results showed that ^{67}Ga-citrate uptake in Ehrlich's tumor tissue at 48 hr after intraperitoneal administration was highest of the three radioisotopes used. The authors believe that this detecting method will prove very useful for this purpose in the future.

48296 EFFECT OF COLLOIDAL CARBON ON RADIOCERIUM METABOLISM IN RATS. Trnovec, T.; Pleskova, A.; Chorvat, D.; Vladar, M. (Inst. of Industrial Hygiene and Occupational Diseases, Bratislava). Strahlentherapie; 143: No. 5, 570-5(May 1972).

The phagocytic activity of the reticuloendothelial system of rats was blocked by means of a single intravenous application of commercial Indian ink or of carbon suspension G. Wagner Pelikan C 11/1431 a. At the same time, a decrease of the ^{131}I-rose bengal clearance from blood was observed, this effect being greater after commercial India ink. The rate of clearance of ^{144}Ce from blood twelve hours after intravenous application of commercial India ink was smaller than in control rats. A decrease in radiocerium liver uptake was also found. The special carbon suspension G. Wagner Pelikan C 11/1431 a for biological purposes did not effect any changes in ^{144}Ce clearance from blood and small shifts in ^{144}Ce organ distribution. These results indirectly point out the role of hepatic parenchyma in initial uptake of radiocerium. (auth)

Plants

48297 (COO-1733-14) STUDY OF UNSUPPORTED ^{210}Po FOR ION EXCHANGE IN SOILS AND UPTAKE IN VEGETATION. Summary Report, 1967-1972. Watters, R. L.; Johnson, J. E. (Colorado State Univ., Fort Collins. Dept. of Radiology and Radiation Biology). 1 Mar 1972. Contract AT(11-1)-1733. 109p. Dep. NTIS.

Studies conducted during 1967 to 1972 on the fate of ^{210}Po deposited in watersheds and agricultural areas are summarized. Results and conclusions are presented for the following studies: distribution coefficients of ^{210}Po for soil profiles of red–yellow podzols, ground water podzols, and lateritic soil; movement of ^{210}Po in contaminated soil under the influence of water percolation; use of electrophoresis and dialysis to characterize chemical species of ^{210}Po in soil; natural ^{210}Po concentration in soils and plants; uptake by plants of unsupported polonium from soils contaminated with $^{210}PoO_2$; foliar absorption of ^{210}Po from $^{210}PoO_2$ contaminations; and characterization of ^{210}Po species in plant tissue. Recent studies on the microdistribution of polonium in plants included the effects of Ca, S, P, and N nutrient deficiencies on the PoO_2 accumulation in barley, corn, oats, and radishes; ultracentrifugation separation of polonium-containing sub-cellular particles; and amino acid analysis of Astragalus osterhouti grown in soil containing polonium oxide. (H.L.W.)

48298 (FOA-4-4491) PLANT UPTAKE OF ^{137}Cs FROM DIFFERENT DEPTHS IN A HOMOGENEOUS SUBSOIL LAYER. Eriksson, Ake; Fredriksson, Lars (Forsvarets Forskningsanstalt, Stockholm (Sweden)). May 1972. 15p. Dep. NTIS (U. S. Sales Only).

Reclamation of heavily contaminated land used for cultivation is a serious problem. Part of this problem was attacked by a series of field experiments in 1961–65. They concerned the possibilities to reduce the root uptake of contaminants by different crops by placement of the contaminated surface soil at different depths in the the soil profile. In the experiment the root uptake of ^{137}Cs from thin layers of contaminated soil on 7, 15, 35, 60, 85 and 110 cm depth was studied. Among the crops the root uptake from the 7 cm depth decreased in the following order: peas > white mustard ≫ oats > rye-grass > barley. The relative uptake decreased strongly with the depth in the profile. For peas, white mustard and rye-grass the uptake from the 35–110 cm layer was ≤ 10 percent of the total, including ≥ 5 percent from the 35–60 cm layer. For oats and barley the root uptake from the 35–110 cm layer was ≤ 30 percent of the total, including 15–20 percent from the 35–60 cm layer, 5–10 percent from the 60–85 cm layer and 2–5 percent from the 85–110 cm layer. (auth) (Sweden)

48299 (ORNL-tr-2595) ^{90}Sr ACTIVITY OF GRAINS AND GRAIN PRODUCTS. Seidler, H.; Hartig, M. Translated by R. Gregg Manfield (Oak Ridge National Lab., Tenn.), from Kernenergie; 4: No. 12, 967-9(Dec 1961). 8p. Dep. NTIS.

The ^{90}Sr activity of cereals (wheat, rye, barley, and oats) of the harvest in West Germany during 1959, as well as the ^{90}Sr concentration of milling fractions (bran, grits, flour), and various bread types are reported. An attempt was made to survey the relationship of the ^{90}Sr activity of grains with the type of production, the fall-out masses, and the fall-out activity. (auth)

48300 (RLO-2227-T-12-30) ECOLOGICAL STUDIES OF RADIOACTIVITY IN THE COLUMBIA RIVER ESTUARY AND ADJACENT PACIFIC OCEAN. Progress Report, July 1, 1971–June 30, 1972. Cutshall, Norman (Oregon State Univ., Corvallis. Dept. of Oceanography). Jul 1972. Contract AT(45-1)-2227. 248p. Dep. NTIS.

Progress is reported on the following research projects: effects of gamma radiation on the reproductive performance of Artemia (brine shrimp) as determined by individual pair matings; effects of gamma radiation on the maintenance of population size in Artemia; zinc-65 specific activities from Oregon and Washington (U.S.A.) continental shelf sediments and benthic invertebrate fauna; radioecology of benthic fishes off Oregon; effects of ocean water on the soluble-suspended distribution of Columbia River radionuclides; calcium-magnesium ratios in the test plates of Allocentrotus fragilis (sea urchin); seasonal concentration, turnover, and mode of accumulation of ^{32}P by the juvenile starry flounder Platichthys stellatus in the Columbia River estuary; zinc, copper, and manganese in the razor clam, Siliqua patulua; effects of photochemical degradation of sediment organic matter on ^{65}Zn release; radioecological kinetics; cadmium turnover in freshwater molluscs; ^{65}Zn turnover in Pacific oysters; ^{65}Zn and ^{54}Mn loss in freshwater molluscs; determination of ^{65}Zn specific activity in mussels and barnacles from the Oregon coast; ^{65}Zn and ^{55}Fe turnover in organs of fishes; radionuclide transport and dispersion; post shutdown radionuclide transport study; movement of Columbia River sediment on the continental shelf; isotope dilution of ^{65}Zn in Oregon coastal waters; effects of seawater on radionuclide form; and spatial patterns of ^{65}Zn specific activity in pelagic and benthic food webs on Oregon's continental shelf. Results of research are also reported on distribution and abundance of marine fishes, invertebrates, and phytoplankton. (H.L.W.)

48301 TRITIUM IN THE BIOSPHERE AND ITS TRANSFER THROUGH THE FOOD CHAIN. Kirchmann, R.; Van den Hoek, J. J. Belge Radiol.; 55: No. 2, 233-42(1972). (In French).

The tritium in the environment originates from natural and artificial sources: the natural production ratio (interaction, cosmic rays on nitrogen and oxygen in the air) and the artificial production ratio (nuclear bomb explosions, power reactors) are indicated. Data on the movement of tritium in the environment and estimates of tritium production and release by nuclear installations are given and briefly commented. The ways in which plant-life is contaminated are numerous (absorption by root or leaf, vapor exchange) and the mechanism responsible for tritium incorporation in plant organic matter is that of photosynthesis. (auth)

New Tracer Techniques

Refer also to abstracts 47654, 48194, 48231, 48236, and 48246.

48302 HOLOGRAMS FOR STORING SCINTIGRAPHIC INFORMATION. Odier, M.; Degrez, A. (Univ., Amiens, France. Univ., Paris). J. Biol. Med. Nucl.; 6: No. 26, 32-3(1971). (In French.

A new principle for the visual display of scintigraphic images is presented. The principle is as follows: each scan yields a continuous track on a transparent plate; each scanning corresponds to a separate plate; the superposition of the successive plates leads to a true three-dimensional image; this image can be photographed from various different directions and plane views in isometric projection can be obtained. The information can be recorded as a single hologram. (France)

48303 EXPLORATION OF THE BONE SKELETON BY EXAMINATION OF THE RADIOACTIVITY PROFILE AFTER INJECTION OF ^{85}Sr. Ramioul, Henri. J. Biol. Med. Nucl.; 6: No. 26, 18-30(1971). (In French).

A technique is presented for exploring the skeleton by recording the radioactivity profile of the vertebral column and pelvis 3 to 5 days after the injection of ^{85}Sr. Radioactivity peaks occur at places where the calcium metabolism is disturbed. The technique is most applicable to the detection of metastatic bone tumors. The method is easy to carry out, innocuous, and reliable and suitable for use in cases where osseous metastases are suspected or knowledge of the extent of a tumor is required. (France)

48304 STUDIES ON THYROIDAL COLLOID PINOCYTOSIS USING A DOUBLE ISOTOPE TECHNIQUE. Pisarev, M. A. (Comision Nacional de Energie Atomica, Buenos Aires); Altschuler, N.; DeGroot, L. J. Acta Endocrinol.; 70: No. 1, 48-55(1972).

A description is given of a double isotope technique for studying pinocytosis of thyroglobulin and fusion of the colloid droplets with lysosomes in the process of secretion of the thyroid hormone. Thyrotrophin (TSH) administration to rats increased the radioactivity present in all fractions, especially in the 15,000 x g pellet. When the subcellular distribution of acid phosphatase was determined, the highest specific activity was found in this fraction, thus indicating the presence of lysosomes. The content of radioactive materials in the 15,000 x g pellet was analyzed by trichloroacetic acid precipitation and by ascending paper chromatography using n-butanol : ethanol : ammonium hydroxide (5 : 1 : 2; v/v) as solvent system. The results obtained showed that 90% of the radioactivity was protein-bound and strongly suggest that this material is thyroglobulin. (auth)

48305 NEW ASSAY OF PHOSPHORYLASE BASED ON THE FILTER PAPER TECHNIQUE. Wang, Palle; Esmann, Viggo (Marselisborg Hospital, Aarhus, Denmark). Anal. Biochem.; 47: No. 2, 495-500(Jun 1972).

A rapid method for assay of phosphorylase was developed. It utilizes the ability of phorphorylase to incorporate ^{14}C-labeled glucose from ^{14}C-glucose 1-phosphate into glycogen, which is then precipitated on filter paper squares by immersion in ice cold 66% ethanol. After removal of surplus ^{14}C-glucose 1-phosphate, the papers are counted directly in a vial containing scintillation fluid. Several buffers were compared and it was found that measuring in a 100-mM maleate buffer gave approximately 15% lower activity than assaying in any of the other seven buffer systems tested. (auth)

48306 RADIOACTIVE ASSAY FOR TYROSINE AMINOTRANSFERASE. Miller, J. V.; Thompson, E. B. (National Cancer Inst., Bethesda, Md.). Anal. Biochem.; 47: No. 2, 487-94(Jun 1972).

A radioactive assay for tyrosine aminotransferase activity, which employs organic extraction to separate product from substrate, is described. The assay is suitable for many samples, has a very low background, and is sensitive enough to measure 2 picograms of enzyme. (auth)

48307 NEW HISTAMINASE ASSAY. Roscoe, Henry G.; Kupfer, David (American Cyanamid Co., Pearl River, N. Y.). Anal. Biochem.; 47: No. 2, 418-25(Jun 1972).

A method for measuring the radioactive products of the action of diamine oxidase on ^{14}C-labeled histamine is described. After reaction of labeled histamine with histaminase, the unreacted histamine is removed by passage through phosphocellulose and the products are collected and counted directly. (auth)

48308 PREPARATION AND ANALYSIS OF L-[^{35}S] METHIONINE LABELED TRANSFER RIBONUCLEIC ACIDS FROM RABBIT LIVER. Stanley, Wendell M. Jr. (Univ. of California, Irvine). Anal. Biochem.; 48: No. 1, 202-16(Jul 1972).

Methods are described for specific labeling with radioactive (^{35}S) methionine of each tRNA species found in rabbit liver cytoplasm. (M.C.G.)

48309 VOLATILE AMINES IN MOUSE BRAIN: A RADIOASSAY WITH PICOGRAM SENSITIVITY. Nixon, Ralph (Harvard Medical School, Boston). Anal. Biochem.; 48: No. 2, 460-70 (Aug 1972).

An isolation procedure and a radioassay for volatile amines in gram quantities of brain tissue are described. The radioassay utilizes ^{3}H-2.4-dinitrofluorobenzene to form radioactive diphenylamine derivatives, which are separated by thin-layer chromatography. The limit of sensitivity of the radioassay is in the picogram range. Seven volatile amines, including two not previously reported, are quantitated in adult mouse brain. (auth)

MATERIALS

48310 (LBL–425) INORGANIC MATERIALS RESEARCH DIVISION ANNUAL REPORT, 1971. (California Univ., Berkeley. Lawrence Berkeley Lab.). Apr 1972. Contract W-7405-eng-48. 202p. Dep. NTIS.

Research progress is reported in sections on chemistry, metallurgy, ceramic science and solid state physics. A separate abstract was prepared for each section. (J.R.D.)

For abstracts of individual sections see: 47737, 48322, 48354, and 49720.

Ceramics and Cermets

Refer also to abstracts 47737, 47738, 47741, 47894, 47931–47935, 47937, 47938, 47948, 47967, 47989, 47995, 48354, 48355, 48391, 48398, 48408, 48414, 48415, 48443, 48444, 48450, 48454, 48473, 49725, 49735, 49738, 49739, 49748, 49760, and 49850.

48311 (AD–739862) INVESTIGATION OF THE BEHAVIOR OF HIGH-TEMPERATURE MATERIALS. Final Report, July 1968–July 1971. Tripp, Walter C.; Rodine, Edward T.; Stroud, John E. (Systems Research Labs., Inc., Dayton, Ohio). Oct 1971. Contract F33615-69-C-1017. 254p. (ARL–71-235). NTIS.

Investigations of selected materials in three principal areas are summarized: defect structure of metal oxides at high temperatures; thermoluminescence of doped and undoped ThO_2 and oxidation of high-temperature materials. Extensive defect structure investigations, including weight and conductivity measurements, were performed on NiO and Sc_2O_3 and the results are presented with a discussion of relevant defect models. Detailed conductivity measurements on CoO were also made. In addition, conductivity data for 76% CeO_2–20% ZrO_2–4% Y_2O_3 are presented. The uv excited thermoluminescence of over 40 single crystals of undoped and rare earth-doped ThO_2 was measured. The major conclusions of the investigation are given. The oxidation program concentrated on two materials— ZrB_2 and ZrB_2 + 20 v/o SiC. Data is also presented on the effect of surface preparation methods on the oxidation of Ti–6Al–4V at 700°C. In addition, oxidation data on several Ni–Cr–Y alloys (1000–1200°C) is included. (auth) (NTIS)

48312 (ANL–7929) ACTINIDE REDISTRIBUTION IN MIXED-OXIDE FUELS IRRADIATED IN A FAST FLUX. Meyer, R. O.; Butler, E. M.; O'Boyle, D. R. (Argonne National Lab., Ill.). May 1972. Contract W-31-109-eng-38. 32p. Dep. NTIS.

Measurements of uranium and plutonium concentrations obtained with an electron-microprobe analyzer are presented for 11 mixed-oxide fuel elements irradiated in EBR-II. The results are consistent with a vapor-transport mechanism in which uranium is preferentially evaporated from the hotter fuel region and transported, by means of porosity, down the temperature gradient. Actinide segregation is closely related to central-void formation, which depends on linear power rating, but for burnups of 1 to 11 at.% no effect of burnup on redistribution was observed. Fuels operated at moderate power ratings showed an enhanced plutonium concentration near the central void that was typically 35 to 50% greater than the initial concentration, whereas unrestructured fuels showed no actinide segregation. Fuel elements that operated with fuel melting sometimes exhibited greater than 100% plutonium enhancement. Various transport mechanisms are discussed, and a quantitative model to predict actinide concentrations is outlined. The effects of actinide redistribution on allowable power rating and Doppler broadening are discussed in the appendix. (auth)

48313 (BARC–582) INFLUENCE OF CRYSTAL SYMMETRY ON THE KINETICS OF THERMAL DECOMPOSITION. Karkhanavala, M. D.; Phadnis, A. B. (Bhabha Atomic Research Centre, Bombay (India)). 1972. 19p. Dep. NTIS (U. S. Sales Only).

The kinetics of thermal decomposition of the different crystallographic modifications of UO_3 (amorphous, α, β, γ, δ, and ϵ) and of $UO_3 \cdot H_2O$(α and β) were studied by thermal gravimetric analysis and differential thermal analysis to evaluate the influence of the crystal structure and symmetry on thermal decomposition. The intermediate phases were characterized also by high temperature x-ray diffractometry as well as by determination of the O/U ratios of the samples quenched from appropriate temperatures. The thermal stability of the different modification of UO_3 increased in the sequence $\alpha < \epsilon <$ amorphous $< \beta < (UO_{2.9}) < \delta < \gamma$. Among the modifications which did not decompose through the intermediate $UO_{2.9}$ phase and whose structures are known with reasonable certainty, i.e., ϵ (triclinic). β (monoclinic), $UO_{2.9}$ (orthorhombic) and γ (pseudotetragonal), not only the thermal stability increased with increasing symmetry, but the activation energy, specific reaction rate constant, frequency factor, and the heat of reaction also increased. Similar observations were made in the case of the hydrates. The hydrates of even the same crystal symmetry exhibited a strong dependence on the compounds from which they were prepared. (auth)

48314 (BARC–601) ^{133}Xe RELEASE FROM IRRADIATED THORIA POWDERS AT LOW TEMPERATURES. Naik, M. C.; Kaimal, K. N. G.; Karkhanavala, M. D. (Bhabha Atomic Research Centre, Bombay (India)). 1972. 12p. Dep. NTIS (U. S. Sales Only).

The release of ^{133}Xe by the knock-out process from sintered ThO_2–0.1% UO_2 powders of different particle size (37 to 45μ, 63 to 75μ, and 105 to 125μ) was measured at low temperatures (<300°C). It was observed that this release is proportional to the specific surface area, fuel burnup, and time of irradiation. The experimental values were compared with the theoretical values. The agreement is found to be reasonably good within experimental errors. For this study, a unit was designed and fabricated to break open under vacuum the quartz ampoules in which the powders were irradiated and sweep out the gases collected in the ampoules during irradiation. (auth)

48315 (COO–3164-3) ORDERING OF HYDROGEN IN β–TANTALUM HYDRIDE. Report No. 1746. Wanagel, J.; Sass, S. L.; Batterman, B. W. (Cornell Univ., Ithaca, N. Y. Dept. of Materials Science and Engineering). Mar 1972. Contract AT(11-1)-3164. 9p. Dep. NTIS.

Electron microscopy was used to study the structure of the β–tantalum hydride phase. The results showed that this phase with a composition estimated to be in the vicinity of Ta_2H has an ordered structure quite similar to that of V_2H. (P.C.H.)

48316 (HEDL-TME-72-85) EQUILIBRIUM OXYGEN POTENTIAL-COMPOSITION RELATIONSHIPS IN $U_{0.75}Pu_{0.25}O_{2-x}$. Woodley, R. E. (Hanford Engineering Development Lab., Richland, Wash.). May 1972. Contract AT(45-1)-2170. 34p. Dep. NTIS.

Variations in the composition of $U_{0.75}Pu_{0.25}O_{2-x}$ as a function of the oxygen potential have been determined by a thermogravimetric technique over the temperature interval 950 to 1400°C. Oxygen potentials, $\Delta\overline{G}_{O_2}$, ranging from –100 to –155 kcal/mole were established by means of $H_2O-H_2-O_2$ equilibria. Values of the partial molar enthalpy, $\Delta\overline{H}_{O_2}$, and entropy, $\Delta\overline{S}_{O_2}$, of solution of O_2 in the mixed-oxide fuel were determined from the temperature dependence of $\ln p_{O_2}$ and $\Delta\overline{G}_{O_2}$, respectively, and found to be independent of temperature at given oxygen-to-metal ratios. (auth)

48317 (HEDL-TME–72-88) FABRICATION MICROSTRUCTURE AND THERMAL CONDUCTIVITY IN UO_2–25 WT. PERCENT PuO_2 SINTERED PELLETS. Gibby, R. L. (Hanford Engineering Development Lab., Richland, Wash.). May 1972. Contract AT(45-1)-2170. 44p. Dep. NTIS.

The effect of pore structure on the thermal conductivity of 90% dense UO_2^- (20 to 25 wt %) PuO_2 fuel pellets was determined at temperatures from 700 to 1500°C. Thermal conductivity was determined from laser heat pulse thermal diffusivity measurements. Thermal conductivity data for samples with closed, isometric pores were found to agree with an established thermal conductivity design equation for mixed-oxides and with the modified Loeb equation recommended for porosity corrections in UO_2. Samples with laminar, open porosity had thermal conductivities as much as 33% less than the design equation while samples with microcrack networks had thermal conductivities as much as 44% less than the design equation. Thermal conductivities for all the samples obeyed the relationship $\lambda_e = (1 - P/1 + \beta P)\ [(1/2.88 + .0252T) + 5.82 \times 10^{-13}T^3]$ to ±10% where T is in °K, P is volume fraction porosity, and β is a pore shape factor. The pore shape factor varied from $\beta = 1.25$ for samples with closed, isometric pores to $\beta \simeq 10$ for samples containing dense microcrack networks. Application of the laboratory thermal conductivity data to refined thermal performance analyses for in-reactor experiments is discussed. Results of an irradiation experiment measuring relative melting heat ratings using fuels of different microstructures (conductivities) were found to be consistent with laboratory measurements. (auth)

48318 (KFK–1592) INVESTIGATIONS ON THE CONSTRUCTION, PREPARATION, AND HARDENING IN THE SYSTEM Ta–Hf–C–N. Komac, M.; Thuemmler, F. (Kernforschungszentrum, Karlsruhe (West Germany). Institut fuer Material und Festkoerperforschung). Apr 1972. 39p. (In German). Dep. NTIS (U. S. Sales Only).

In the pseudo ternary system $TaC_{1-x}-TaN_x-HfN$, samples were hot pressed to 85 to 95% TD and annealed afterwards to achieve better homogeneity. Special attention was drawn to the binaries $TaC_{1-x}-TaN$ and $TaC_{1-x}-HfN$ as well as the ternary composition with 80 and 60 mole % TaC_{1-x}. The boundaries of the cubic phase, the lattice parameters and microhardness at room temperature versus compositions, and the microhardness of special compositions up to 1000°C were investigated. All samples were analyzed for O_{total}, C_{free}, and N in order to define their stoichiometry exactly. The dependency of lattice parameters is discussed. The nitrogen containing samples showed considerably higher hardness numbers than $TaC_{1.0}$, that can be explained in terms of valence electron concentration. Nevertheless, the carbonitrides did not reach the maximum hardness of TaC_{1-x} at room temperature. In tantalum carbonitrides and TaC_{1-x}, the deviations from stoichiometry were probably responsible for the hardness increase and the nitrogen content does not contribute for itself in this respect. TaC−TaN exhibited maximum hardness values in the medium range. The highest hardness values at high temperatures for (TaHf) (CN) were due to its relatively low-temperature dependence of hardness. A favorable composition with this respect is 60 TaC/20 HfN/20 TaN. Such compositions could become important for hard metal technology. It was shown that a conclusive discussion of properties of these mixed phases is only valuable with thorough consideration of metalloid/metal ratio. (auth)

48319 (LA–4945) THERMAL EXPANSION OF PuO_2. Nutt, A. W.; Tokar, M. (Los Alamos Scientific Lab., N. Mex.). Jun 1972. Contract W-7405-eng-36. 5p. Dep. NTIS.

The linear thermal expansion of stoichiometric $^{239}PuO_2$ was measured from 25 to 1420°C. A polynominal least squares fit of the expansion data yielded the linear expansion expression (in cm/cm °C): $\Delta L/L_0 = -1.2232 \times 10^{-4} + 7.5866 \times 10^{-6}\,T + 5.6948 \times 10^{-9}\,T^2 - 5.9768 \times 10^{-12}\,T^3 + 4.4092 \times 10^{-15}\,T^4 - 1.2897 \times 10^{-18}\,T^5$. The mean linear expansion coefficient from 25 to 1420°C was 11.16×10^6 cm/cm °C. (auth)

48320 (LA–4959) THERMODYNAMIC STABILITY CONSIDERATIONS IN THE Mo–BN–C SYSTEM. APPLICATION TO PROTOTYPE SUBTERRENE PENETRATORS. Krupka, M. C. (Los Alamos Scientific Lab., N. Mex.). May 1972. Contract W-7405-eng-36. 11p. Dep. NTIS.

Materials capable of operation for extended lifetimes at high temperatures are required for use as rock-melting penetrators. In prototypes presently designed molybdenum, boron nitride, and high density graphite are used as high temperature materials. The integral design features of the penetrator system suggest that consideration be given, from a thermodynamic viewpoint, to the potential for chemical reactivity among the components. Standard Gibbs free energy calculations at selected temperatures have been made for the composite system and the relative potential for chemical reactivity assessed. Postmortem examination has been made of some penetrators and the observations are discussed within the framework of the calculations. Suggestions for minimizing chemical reaction are given under the assumption that these materials may be retained for future designs of penetrators. (auth)

48321 (LA–4993) ADVANCED PLUTONIUM FUELS PROGRAM. Quarterly Report, January 1–March 31, 1972. Baker, R. D. (comp.) (Los Alamos Scientific Lab., N. Mex.). Jun 1972. Contract W-7405-eng-36. 29p. Dep. NTIS.

Research directed toward determining the effects of neutron irradiation on LMFBR fuel materials is reported. Work in a parallel program to evaluate the most promising candidate fuel systems for advanced LMFBR application is also reported along with work directed to development of analytical standards for fast breeder reactor oxide fuels. (J.R.D.)

48322 (LBL–425, pp 145-66) CERAMIC SCIENCE. Apr 1972.

Research is reported on high temperature reactions and microstructure and properties of ceramics and cermets. (J.R.D.)

48323 (N–71–35580) DEVELOPMENT OF A CHROMIUM–THORIA ALLOY. Veigel, N. D.; Wilcox, B. A.; Blocher, J. M. Jr.; Clauer, A. H.; Seifert, D. A.; (and others) (Battelle Memorial Inst., Columbus, Ohio). 10 Mar 1971. Contract NAS3-12435). 96p. (NASA-CR-72901). NTIS.

A vapor-deposition apparatus was designed, constructed, and used to prepare chromium and chromium-3 without ThO_2 powders in 114 to 227 g lots. The powders were consolidated by hot isostatic pressing, rolled to sheet, and evaluated in sheet form. The addition of thoria lowered the ductile-to-brittle transition temperature both in the as-rolled and annealed (1 h at 1200°C) conditions. After high-temperature annealing (up to 1427°C), the $Cr-ThO_2$ alloys recrystallized with elongated grains. Although such a structure should have good high temperature strength, no improvement was observed, probably because the microstructure was less than optimum. (auth) (STAR)

48324 (NAA-SR-Memo–8464) MECHANICAL PROPERTIES OF LiH. PART II. TRANSVERSE RUPTURE TESTS. Lundberg, L. B. (Atomics International, Canoga Park, Calif.). 7 May 1963. Contract AT-11-1-GEN-8. 7p. Dep. NTIS. Declassified 8 Nov 1971

Transverse rupture tests were performed on cold pressed and sintered lithium hydride at 120, 700, and 800°F in a dynamic helium atmosphere. It was found that the modulus of rupture for lithium hydride at 120°F (4050 psi) was equivalent to the ultimate tensile strength at this temperature, but this relationship was not true for the other two test temperatures. Significant weakening of lithium hydride was noted at elevated temperatures. (auth)

48325 (PEL–222) MELTING URANIUM DIOXIDE BY HIGH-FREQUENCY INDUCTION. Lovell, G. H. B.; Britz, E. J. (Atomic Energy Board, Pelindaba, Pretoria (South Africa)). Mar 1972. 9p. Dep. NTIS (U. S. Sales Only).

Methods for the small-scale melting of UO_2 are reviewed and the development of a method using high-frequency induction heating is described. The apparatus represents an advance on the designs described in the literature up to the time of writing. (auth)

48326 (RCN–162) PROGRESS REPORT OF THE MATERIALS DEPARTMENT, THIRD QUARTER 1971. Blackstone, R. (ed.) (Reactor Centrum Nederland, Petten). Dec 1971. 59p. Dep. NTIS (U. S. Sales Only).

A description is given of the progress in the various projects concerning materials development for water-cooled reactors, sodium-cooled fast reactors, and gas-cooled reactors. (auth)

48327 (RD/B/N–2281) MORPHOLOGY AND GROWTH RATE OF INTERLINKED POROSITY IN IRRADIATED UO_2. Beere, W.; Reynolds, G. L. (Central Electricity Generating Board, Berkeley (England). Berkeley Nuclear Labs.). May 1972. 20p. (AEA/UFWP/P–(72)7). Dep. NTIS (U. S. Sales Only).

A quantitative assessment is made of the morphology of penetrating phases formed along grain boundary edges. The free energy of the configurations is calculated and critical conditions are found for instability and extensive interlinkage. The method is extended to cover the morphology of interlinked gas bubbles and the results are applied to swelling in irradiated UO_2. The model developed predicts significant gas release after an incubation period and that subsequent release is by repeated venting of the interlinked porosity. Estimates are made of the characteristic times between venting. (auth)

48328 NONSWELLING URANIUM NITRIDE FUEL. Chubb, Walston; Keller, Donald L.; Wullaert, Richard A.; Storhok, Victor (to United States Atomic Energy Commission). U. S. Patent 3,661,709. 9 May 1972. Filed 6 Apr 1970.

A high-temperature dimensionally stable nuclear reactor fuel element containing tungsten and uranium nitride in the form of a cermet or uranium nitride in which the particle size of the fuel material is not larger than the grain size of the uranium nitride and in which the fuel region contains 20 to 30 volume percent of highly interconnected porosity evenly distributed throughout the fuel region is described. (Official Gazette)

48329 HETEROGENEOUS–HOMOGENEOUS OXIDATION OF OXIDE CATALYSTS. Il'chenko, N. I.; Golodets, G. I.; Pyatnitskii, Yu. I. (Inst. of Physical Chemistry, Kiev). Dokl. Akad. Nauk SSSR; 203: No. 1, 112-15(1 Mar 1972). (In Russian).

The kinetics of the oxidation of hydrogen by Y_2O_5 and $Y_2O_5-MoO_3$ with 20, 30, and 50 mole % MoO_3 were studied over the temperature range 400 to 500°C, employing a static circulating arrangement which froze out water vapor. The oxidation rate was the greatest in the case of pure Y_2O_5, but variable with MoO_3 content. Adding O_2 to the system increased the rate of oxidation until 100 to 200 torr of O_2 was reached, and then the rate declined (for a constant H_2 pressure of 21 torr). Other variables discussed include temperature and the Y_2O_5/MoO_3 ratio. (K.S.W.)

48330 FABRICATION OF SINTERED PELLETS OF MIXED OXIDES OF Th AND U WITH LOW CONCENTRATION OF U FOR FUEL ELEMENTS. Liscia, A.; Zanelli, S. (CNEN, Saluggia, Italy). Atti Notiz. (Publ. in Met. Ital.); 26: No. 4, 134-8(Apr 1971). (In Italian).

The method of preparation of Th and U powders and in particular the precipitation of the oxalates and the calcination operation were studied. The precipitation conditions for the oxalate greatly influence the density of the solid obtained by sintering the oxide power prepared by calcination of the oxalates themselves. It is necessary that the precipitation occur with high rate of nucleation and low residence times for crystals in the precipitator in order to limit the crystal growth. The importance of an excess of oxalic acid is discussed. It was possible to obtain sufficiently high density at temperature of 6°C, which requires a coolant circuit, using oxalic acid excesses greater than 20%, residence times in the precipitator of 10 or 5 min, at temperatures between 19 and 24°C. (tr-auth)

48331 HIGH MODULUS: FIBERS AND COMPOSITES. Galasso, Francis S. New York; Gordon and Breach, Science Publishers, Inc. (1969). 123p.

The state-of-the-art of high modulus fibers and composites in the spring of 1969, which began in the early 1960's, is presented. Chapters are included on: general features of glass and metal fibers, whiskers, and high modulus filaments; boron fibers; carbon fibers; other high modulus fibers; and composites. A list of eutectics and data are appended. (P.C.H.)

48332 THERMAL EXPANSION OF Nb_2O_5. Manning, W. R.; Hunter, O. Jr.; Calderwood, F. W.; Stacy, D. W. (Ames Lab., Iowa). J. Amer. Ceram. Soc.; 55: No. 7, 342-7(Jul 1972).

The high-temperature thermal expansion of monoclinic Nb_2O_5 was studied with x-ray and dilatometric techniques. The x-ray axial thermal expansion was anisotropic; the mean coefficients in the a, b, and c directions, respectively, were 5.3, 0, and 5.9 × 10^{-6}°C^{-1} from room temperature to 1000°C. It is proposed that this anisotropy causes microcrack formation in sintered polycrystalline samples. The bulk linear thermal expansion of both sintered and hot-pressed samples was determined with a dilatometer from room temperature to 1200°C. A hysteresis effect between heating and cooling data observed for sintered samples was attributed to the occurrence and recombination of internal microcracks. (auth)

48333 SIMULATION OF GASEOUS FISSION PRODUCTS IN UO_2. Marlowe, M. O. (General Electric Co., Pleasanton, Calif.). J. Amer. Ceram. Soc.; 55: No. 7, 379-80(Jul 1972).

The gaseous fission products of UO_2 were simulated by trapping the gases in the solid during sputtering. A UO_2 target 6.7 cm in diameter and 0.5 cm thick was fabricated by cold-pressing and sintering in a vacuum at 1500°C. Sputtering was conducted in Ar. At an Ar pressure of 2×10^{-2} torr, the deposition rate was 50 Å/min. No attempt was made to optimize the deposition rate. Specimens ≈1500Å thick deposited on glass slides were stripped from the slide and picked up on Cu-mesh grids for transmission electron microscopy. The as-sputtered UO_2 films were very fine grained but polycrystalline. The calculated lattice parameter (a_0) was 5.48 ± 0.02 Å. Heating of the specimens in situ in the electron beam of the microscope resulted in grain growth and the appearance of minute bubbles (50 Å in diameter) on the grain boundaries; intergranular bubbles were also observed. Continued grain growth was observed on continued heating, and gas accumulated at the grain boundaries. The Ar content of UO_2 films sputtered at 2×10^{-2} torr was 13.1 mole %. (P.C.H.)

48334 IRRADIATION BEHAVIOR OF BORON CARBIDE. Copeland, G. L.; Donnelly, R. G.; Martin, W. R. (Oak Ridge National Lab., Tenn.). Nucl. Technol.; 16: No. 1, 226-37 (Oct 1972).

Boron carbide is the prime candidate material for neutron absorbers in fast breeder reactors and the Fast Test Reactor. Important data required for design of control rods for these reactors concern swelling, gas release, and structural integrity of boron carbide under the expected operating conditions. Data for irradiations of boron carbide powders in a thermal reactor and powders and pellets in a fast reactor are presented and discussed in terms of expected performance in a fast reactor. The most important variable in determining irradiation behavior appears to be the mobility of the helium produced. The helium is not trapped in the lattice but precipitates. Denuded zones and absence of bubbles on grain boundaries suggest that helium diffuses rapidly along the grain boundaries. This is a major source of gas release. (auth)

48335 EMPIRICAL HELIUM RELEASE FUNCTION FROM THERMAL REACTOR IRRADIATED BORON CARBIDE. Russcher, G. E.; Pitner, A. L. (Westinghouse Hanford Co., Richland, Wash.). Nucl. Technol.; 16: No. 1, 208-15(Oct 1972).

Thirty-five sets of thermal reactor data were analyzed mathematically to derive a best fit function to predict gas release from boron carbide as a function of temperature, irradiation exposure, and material density. An exposure variable to account for difference in self-shielding in various reactor spectra was developed. The data used in the analysis included temperatures from 550 to 1200°F, irradiation exposures from 10×10^{20} to 31×10^{20} captures/g, and material densities of 2.0 and 2.5 g/cc (80 and 99% of the theoretical density). Within this range the function should predict gas release in all reactor spectra within the 20% estimated accuracy of the experimental data. Independent gas release data generated in fast and intermediate reactor spectra showed that the general form of the function is correct but that application to temperature conditions above the specified range may result in overestimates of gas release. (auth)

48336 IRRADIATION-INDUCED DIMENSIONAL CHANGE IN BORONATED GRAPHITE. Stansfield, O. M. (Gulf General Atomic Co., San Diego, Calif.). Nucl. Technol.; 16: No. 1, 197-207(Oct 1972).

Boronated graphites containing 22 to 43 wt % boron as B_4C and representing current warm-pressing or extrusion technology were irradiated at 650 ± 100°C to fast neutron fluences up to 7×10^{21} n/cm^2 (E > 0.18 MeV). The irradiation caused an increase in thermal expansivity, a decrease in thermal conductivity, and an anisotropic dimensional change related to the preferred orientation of the graphite crystallites in the graphite matrix. Although irradiation-induced B_4C swelling has been reported, the dimensional change in boronated graphite is not significantly influenced by that effect. Dimensional change in boronated graphite is controlled by the fast neutron and ^{10}B fission damage irradiation properties of the graphite-binder matrix. At a constant ^{10}B-isotope concentration, the irradiation-induced dimensional change of the boronated graphite increases with increasing ^{10}B-isotope enrichment of the boron in the B_4C addition. This effect, which may result from more severe ^{10}B fission fragment damage in the matrix surrounding ^{10}B-enriched B_4C, leads to distortion directly related to the ^{10}B burnup gradient. The use of natural boron in the fabrication of boronated graphite results in dimensional changes independent of the ^{10}B burnup gradient and correlated with fast neutron fluence under HTGR service conditions. (auth)

48337 POSTIRRADIATION OBSERVATIONS OF MIXED OXIDES WITH INITIAL ADDITION OF FISSION PRODUCT ELEMENTS. Conte, M.; Mouchnino, M.; Schmitz, F. K. (CEN, Fontenay-aux-Roses, France). Nucl. Technol.; 16: No. 1, 143-55(Oct 1972).

A mixed oxide $(U,Pu)O_2$ containing five elements (Mo, Ru, Ba, Zr, and Ce) representative of the fission product yield at 150,000 MWd/t has undergone a short-time irradiation to obtain the characteristic microstructure changes and redistribution of addition elements. The most important post-irradiation observations on these oxides include the absence of the columnar structure in the samples containing molybdenum, a plutonium enrichment in the center of stoichiometric oxides, and the presence of a metallic ingot at the upper end of the central void in one of the pins containing ruthenium. The thermal behavior has been shown to be unfavorably affected by fabrications parameters in the case of low O/M, low density, and addition of soluble elements, whereas stoichiometric composition and possibly addition of Mo are favorable characteristics. The O/M ratio has been found to be the most important parameter to govern the migration of actinides and fission products. (auth)

48338 AN EVALUATION OF THE EFFECT OF INTERGRANULAR ATTACK ON FUEL PIN BURST PROPERTIES. Ring, P. J.; Challenger, K. D.; Busboom, H. J. (General Electric Co., San Jose Calif.). Nucl. Technol.; 16: No. 1, 64-74 (Oct 1972).

Burst rupture tests have been carried out on irradiated fuel pin cladding to determine the effect of intergranular attack on burst rupture strength and ductility, and to assess the ability of the weakened cladding to withstand power surge or loss of coolant. The results from this series of tests indicate that the burst rupture strength or yield strength is not drastically reduced by localized attack extending through as much as 35% of the cladding thickness. Ductility values, however, do appear to be substantially reduced. In terms of reactor operation, this suggests that in a transient stress situation the cladding would be able to withstand higher stresses than previously predicted using a wall thinning criteria, based on the maximum depth of cladding attack, but would tolerate far less deformation than unattacked cladding before failure. (auth)

48339 PRODUCTION-SCALE FORMATION OF ULTRAHIGH PURITY CARBIDE POWDERS. Davidson, Keith Vernon; Schell, Donald H. (to United States Atomic Energy Commission). U. S. Patent 3,666,845. 30 May 1972. Filed 6 May 1970.

A method is described for forming ultrahigh purity carbide powders (UC – ZrC) on a production scale, which comprises blending metal oxide powders with elemental carbon powders and a partially polymerized furfuryl alcohol binder together with a suitable polymerization catalyst, extruding, polymerizing the binder, heating to 840°C for 48 hours in a soft vacuum, heating to 2,200°C for 1 hour in a helium atmosphere, cooling, crushing, and then heating to 2,000°C for 24 hours under a vacuum. (Official Gazette)

48340 PROCESS FOR PREPARING MULTI-COMPONENT NUCLEAR FUELS. Triggiani, Leonard V.; Sanchez, Moises G. (to W. R. Grace and Co.). U. S. Patent 3,671,453. 20 Jun 1972. Filed 24 Sep 1969.

A process is described for preparing particles, powders, spheres, and other shapes of uranium carbide or uranium nitride and/or thorium carbide or thorium nitride containing significant amounts of a second fissionable component. The particles are prepared by impregnating a matrix with a sol or other suitable dispersion of the fissionable component. (Official Gazette)

48341 PEROVSKITE PHASES IN THE SYSTEMS $BaO-Se_2O_3-UO_{2x}$. III. SOLID SOLUTIONS $Ba_2La_{0.67}UO_{5.5}-Ba_2Ba_{0.67}U_{1.33}O_6$. Kemmler-Sack, S.; Wall, I. (Univ., Tuebingen, Ger.). Z. Naturforsch.; 26b: No. 12, 1229-31(Dec 1971). (In German).

$Ba_2La_{0.67}UO_{5.5}$ and $Ba_2Ba_{0.67}U_{1.33}O_6$ form solid solutions with ordered cubic perovskite structure. According to optic and magnetic measurements, they contain U(V) in the centers of distorted octahedrons and lanthanum always occupies the sixfold coordinated positions. (auth)

48342 CONTINUOUS PROCESS FOR THE PRODUCTION OF HIGH-DENSITY THORIA. Burkhardt, Winston (to United States Atomic Energy Commission). U. S. Patent 3,666,426. 30 May 1972. Filed 1 May 1969.

A method is described for preparing thoria from an aqueous solution of thorium nitrate which comprises mixing the solution with an aqueous basic solution of ammonia continuously at a temperature in the range 180 to 200°F under such conditions that the pH of the resulting slurry as would be measured at 25°C is at a value in the range 5.0 to 6.5, and then filtering the resultant precipitate. (Official Gazette)

48343 FREEZE-DRYING METALS AND CERAMICS. Gelles, S. H.; Roehrig, F. K. J. Metals; 24: No. 6, 23-4(Jun 1972).

The feasibility of producing fine-grained pure metals, solid-solution alloys, dispersion-strengthened alloys, carbides, and mixed-oxide ceramics by the freeze-dry process is discussed. Advantages of the process include: potential for the production of metal and ceramic powders in the areas of fine-grain effects, dispersion-strengthening, homogeneous alloys and ceramic materials; and in the fine powder size of the products, the ability to produce a uniform and homogeneous product. An example of the process in the production of Pb—10 vol % MgO powder is presented. (P.C.H.)

48344 QUICK LOADING STRENGTH OF $Na_2O-B_2O_3-SiO_2$ GLASS FIBERS. Hasegawa, H.; Nishihama, K.; Imaoka, M. (Tokyo Univ.). J. Non-Cryst. Solids; 7: 93-102(1972).

The quick loading tensile strength of the glass fibers in the system $Na_2O-B_2O_3-SiO_2$ was measured with a loading time of 10^{-3} second. When the Na_2O content was 10 mole %, the observed values were close to the theoretical strengths calculated using Orowan's formula, that is, about 80% of the theoretical values, on an average. The observed strengths relative to the theoretical values, however, became smaller with increasing content of Na_2O and B_2O_3, probably because the fibers were subjected to fatigue caused by the poorer chemical durability. (auth)

48345 ThCN CRYSTAL STRUCTURE. Benz, R. (Los Alamos Scientific Lab., N. Mex.); Arnold, G. P.; Zachariasen, W. H. Acta Crystallogr., Sect. B; 28: 1724-32(1972).

The crystal structure of ThCN was determined from x-ray and neutron diffraction powder patterns as being C-centered monoclinic, space group $C2/m(C_{2h}^3)$, with the unit-cell dimensions $a_0 = 7.0249 \pm 0.0006$, $b_0 = 3.9461 \pm 0.0002$, $c_0 = 7.2763 \pm 0.0009$ Å, and $\beta = 95.67 \pm 0.01°$. Atomic positions are $(000)(\frac{1}{2}\frac{1}{2}0)$ + 4Th in $\pm(x_{Th},0,z_{Th})$, 4C in $\pm(x_C,0,z_C)$, and 4N in $\pm(x_N,0,z_N)$, where $x_{Th} = 0.177 \pm 0.005$, $z_{Th} = 0.200 \pm 0.003$, $x_C = 0.444 \pm 0.005$, $z_C = 0.560 \pm 0.005$, $x_N = 0.153 \pm 0.005$, and $z_N = 0.875 \pm 0.005$. The carbon atoms in the structure occur as triply bonded pairs. (auth) (Denmark)

48346 ANALYSIS OF THE SUPERSTRUCTURE OF U_4O_9 BY NEUTRON DIFFRACTION. Masaki, Norio; Doi, Kenji (JAERI, Ibarki, Japan). Acta Crystallogr., Sect. B; 28: 785-9(1972).

The superlattice structure of U_4O_9 at room temperature is cubic (space group $I4_132$), with the cell dimension 21.76 Å, which is 4 times that of the fundamental structure of U_4O_8 (= UO_2). Structure analysis was made with single-crystal neutron diffraction from the hk0 superlattice reflexions. The arrangement of 64 additional oxygen atoms in the superlattice and the displacements of the uranium atoms from the positions in the fluorite-type fundamental structure are determined. Forty of the 64 additional oxygen atoms are located at the centers of interstices formed by cubes of oxygen atoms in a fluorite-type structure. The remaining 24 atoms are displaced from the centers of the interstices by 0.52 Å along the face-diagonal directions. Of the 256 uranium atoms constituting the fluorite-type structure, 16 are found to be displaced by 0.45 Å along the body-diagonal directions from their normal positions. (auth) (Denmark)

48347 LATERAL PRESSURE DISTRIBUTION IN THE COMPACTION OF TUNGSTEN CARBIDE—COBALT MIXTURES. Meerson, G. A.; Ivensen, V. A.; Sapronov, E. I.; Vissarionov, V. B. (All-Union Scientific-Research Inst. of Refractory Metals and Hard Alloys, Moscow). Sov. Powder Met. Metal Ceram. (Engl. Transl.); 11: No. 2, 95-7(Feb 1972).

Translated from Porosh. Met., Akad. Nauk Ukr. SSR; 11: No. 2, 15-18(Feb 1972).

A tensometric apparatus was constructed for measuring the lateral pressure in powder compaction by the deformation of individual ring elements forming the body of a die. With increasing distance from the upper, pressing punch (in single-ended pressing), the lateral pressure did not change monotonically, but according to a more complex law, in the case of tungsten carbide—cobalt mixtures, depended on the amount of the ductile metal (cobalt). The presence of cobalt facilitated relative displacement of the carbide particles and increased the friction of the powder on the die wall. The combined action of these factors determined the character of vertical and lateral pressure distributions along the height of the mass being pressed. (auth)

48348 SOLID-PHASE REACTIONS OF Ta_2O_5 WITH Ga_2O_3 AND In_2O_3. Plotkin, S. S.; Plyushchev, V. E. (Moscow Inst. of Fine Chemical Tech.). Sov. Powder Met. Metal Ceram. (Engl. Transl.); 11: No. 2, 137-40(Feb 1972).

Translated from Porosh. Met., Akad. Nauk Ukr. SSR; 11: No. 2, 69-73(Feb 1972).

Using the techniques of DTA and x-ray phase analysis, a study was made of the reactions between Ta_2O_5 and M_2O_3 (M = Ga or In), and the phase compositions of the relevant binary systems were determined. The existence was confirmed of stable compounds of composition $MTaO_4$ and eutectoidally decomposing phases containing 7.5 to 12.5 mole % M_2O_3. $MTaO_4$ are dielectrics, whose room-temperature ρ_v is of the order of 10^{10} Ω-cm. The temperature dependence of ρ_v of $MTaO_4$ was investigated in the range 293 to 873°K and their energies of activation for conductivity were calculated. The melting points, pyknometric densities, dielectric losses, and relative dielectric permeabilities of $MTaO_4$ were determined. (auth)

48349 METALLOGRAPHIC INVESTIGATION OF HARD FACING NIOBIUM AND MOLYBDENUM CARBIDE DEPOSITS. Krasnov, A. N.; Kravets, Zh. A. (Inst. of Materials Science, Kiev). Sov. Powder Met. Metal Ceram. (Engl. Transl.); 11: No. 2, 167-9(Feb 1972).

Translated from Porosh. Met., Akad. Nauk Ukr. SSR; 11: No. 2, 104-7(Feb 1972).

It was demonstrated that, in principle, it is possible to hard face steel with pure carbides. The resultant deposit exhibited high hardness. During facing with an open arc, the carbon partially burned out, altering the initial composition of the carbide. (auth)

48350 REDISTRIBUTION OF MOLTEN COBALT IN POWDER METALLURGICAL WC—Co HARD ALLOYS. Lisovskii, A. F.; Babich, M. M. (Inst. of Superhard Materials, Kiev). Sov. Powder Met. Metal Ceram. (Engl. Transl.); 11: No. 2, 124-8(Feb 1972).

Translated from Porosh. Met., Akad. Nauk Ukr. SSR; 11: No. 2, 53-8(Feb 1972).

Studies were made on the cobalt redistribution process and the conditions under which the liquid phase in hard alloys is in equilibrium in order to improve methods for the manufacture of components having a predetermined, nonuniform distribution of Co over their cross section. From the results it was found that when the equilibrium of the liquid was disturbed, a redistribution of molten Co did take place. As a result of this process, the Co contents of specimens may become equalized or the Co concentration gradient may become steeper. Two general characteristics of the molten Co redistribution process are that the difference between the values of the $(1-q)^{1/3}/rq^{1/3}$ ratio for specimens decreases and the liquid phase tends to an equilibrium. It was concluded that by making use of the relations established, it is possible to determine the direction of migration of the liquid phase in alloys, evaluate the concentration of Co after its redistribution, and prevent Co from being redistributed between two parts of a component by choosing alloys satisfying a certain condition. (P.C.H.)

48351 METAL—BORON—NITROGEN SYSTEMS. A SURVEY. Medvedeva, O. A. (Inst. of Materials Science, Kiev). Sov. Powder Met. Metal Ceram. (Engl. Transl.); 11: No. 2, 113-18(Feb 1972).

Translated from Porosh. Met., Akad. Nauk Ukr. SSR; 11: No. 2, 38-45(Feb 1972).

Studies were made on the systems Ti (Zr, Hf)−B−N, V (Nb, Ta)−B−N, Cr (W)−B−N, and Fe−B−N by considering the chemical nature of borides and nitrides forming ternary systems, their crystal lattices, atomic size relations, and the position of the metal in the periodic system. From the results it was possible to draw the general conclusion that the equilibria in a Me−B−N system depend on the metallochemical and crystal structure properties of the compounds forming the system and vary in a regular manner as a function of the difference between these properties. (P.C.H.)

48352 MEETING ON THE IMPROVEMENT OF MECHANICAL PROPERTIES AT HIGH TEMPERATURES, CLERMONT-FERRAND, FRANCE, OCTOBER 22, 1970. Rev. Int. Hautes Temp. Refract.; 9: No. 1, 7-130(Jan 1972). (In French). (CONF-701028).

Thirteen articles are included; separate abstracts were prepared for three. One article was previously abstracted in NSA as 25: 11485. The remaining nine articles contain information on: superalloys; welded Al alloys available at temperatures higher than 100°C; thermostable polymers; reinforcement of metals by refractory fibers; high-temperature composites; microcalorimetric determination of enthalpy of sublimation of Zn and Te; study on the fluoritic phase in the system CeO_2-ZrO_2-CoO; x-ray and electron microscopy studies on existence and stability of β and β'' aluminum oxides in the system $Al_2O_3-Na_2O$; fluoride phase under pressure of sodium−aluminum fluoride rich in aluminum fluoride. (P.C.H.)

For abstracts of individual papers see: 48353, 48384, and 48437.

48353 FUEL ELEMENTS FOR HIGH TEMPERATURE GAS COOLED REACTORS. Herrmann, F. J.; Huschka, H.; Venet, P. (NUKEM, Hanau, Ger.). Rev. Int. Hautes Temp. Refract.; 9: No. 1, 101-16(Jan 1972). (In French).

From Meeting of the French Society of High Temperatures; Clermont-Ferrand, France (22 Oct 1970). See CONF-701028.

Developments in high-temperature reactor fuel elements necessitated improvements in their mechanical, physical, and nuclear performances. The problems arising are associated with the fact that these nuclear fuel elements must conserve their properties and integrity over long periods of exposure to neutron and γ fluxes at operating temperatures varying between 750 and 1500°C. These conditions resulted in the utilization of a quasi-homogeneous dispersion of ceramic fuel in a graphite structure. The fuel used is in the form of spherical particles having diameters between 200 and 800 μ, which are coated with several layers of pyrolitic carbon and possibly with a silicon carbide layer. (France)

Metals and Alloys

Refer also to abstract 47737.

48354 (LBL—425, pp 83-143) METALLURGY. Apr 1972. In Inorganic Materials Research Division annual report, 1971.

Research results are presented on crystal imperfections, plastic deformation, thermodynamics of inhomogeneous materials, relations of structure with properties, electron microscopy, high strength materials, superconductivity, thermodynamics of metal systems, and advanced materials. (J.R.D.)

48355 PLUTONIUM-DOKUMENTATION. Referate-Zeitschrift mit Anhang Transplutonium-Elemente. Juni 1972. Band 6, Heft 6. 165 Referate (Register-Nr.1658-1950), 83 Referate (Register-Nr.404 T-486 T). (Plutonium-Documentation. Abstract Journal with Appendix on Transplutonium Elements. June 1972. Vol. 6, No. 6. 165 Abstracts (Register No. 1658-1950), 83 Abstracts (Register No. 404 T-486 T)). Karlsruhe, Ger.; Gesellschaft fuer Kernforschung m.b.H (1972). 110p. (In German and English).

Corrosion and Erosion

Refer also to abstract 47796.

48356 (GAT-T-1868) METAL/ENVIRONMENT REACTIONS AT ELEVATED TEMPERATURES. Costin, Darryl J. (Goodyear Atomic Corp., Piketon, Ohio). 13 Dec 1971. Contract AT(33-2)-1. 59p. Dep. NTIS.

A compilation of nine lectures given at the GAT Metallurgy Department Seminar on Metal/Environment Reactions at Elevated Temperatures is presented. Lectures were devoted to a semi-quantitative analysis of point defect theory and to the kinetics of high-temperature oxidation. In light of the appreciable amount of research on the various aspects of metal/gas reactions conducted in the gaseous diffusion industry, this series of lectures may serve as a supplement to pertinent project investigation. (auth)

48357 (HEDL-TME-72-71) ACTIVATED CORROSION PRODUCT RADIATION LEVELS NEAR FFTF REACTOR AND CLOSED LOOP PRIMARY SYSTEM COMPONENTS. Kabele, T. J.; Brehm, W. F.; Marr, D. R. (Hanford Engineering Development Lab., Richland, Wash.). 15 May 1972. Contract AT(45-1)-2170. 48p. Dep. NTIS.

Estimates are presented of the radiation levels in an FFTF reactor Heat Transport System (HTS) cell and near a Closed Loop System (CLS) module due to activated stainless steel corrosion product deposits in primary system piping and components. ^{60}Co, ^{58}Co, ^{54}Mn, ^{51}Cr, ^{59}Fe, and ^{182}Ta were considered as corrosion products for this analysis. In an HTS cell, the general radiation levels due to activated corrosion products were predicted to be in the range of 1 to 15 R/h; near a CLS module the levels were predicted to be 30 to 1000 mR/h, both after five years of reactor operation at ultimate conditions. The corrosion product radiation levels in an HTS cell were predicted to be high enough to interfere with contact maintenance. Levels near a CLS module may or may not affect contact maintenance. Selective shielding of single, major components in either an HTS cell or a CLS module was shown to be ineffective because of the wide distribution of corrosion product deposits (and hence radiation sources). Reducing the oxygen level of the sodium was predicted to cause a reduction in the general radiation levels. However, there is only meager experimental evidence to support this prediction and it must be used cautiously. Only radiation due to activated corrosion products is considered. Radiation due to activated sodium or to fission products from failed or vented fuel was not evaluated. (auth)

48358 (JAERI-Memo—4019) METALLURGICAL INVESTIGATIONS ON THE CLADDING FAILURE IN THE JPDR PRESSURE VESSEL. II. A STUDY ON THE PITTING CORROSION IN HIGH TEMPERATURE WATER OF A LOW ALLOY STEEL WITHIN THE SIMULATED CRACKS IN THE PROTECTIVE WELD OVERLAY. Kondo, Tatsuo; Nagasaki, Ryukichi; Shimizu, Yoshihiko; Ito, Goro (Japan Atomic Energy Research Inst., Tokyo). May 1970. (In Japanese). NTIS (U. S. Sales Only).

Crevices formed by failure in the stainless steel cladding of the JPDR pressure vessel wall have been suspected to cause localized attack, pitting, of the base metal inside those due to the exposure to hot coolant water under possible unusual electrochemical condition in such area. Three types of specimens, which were designed to simulate geometrically the cracked state with respect to the crevice corrosion effect, were exposed to high temperature recirculating water for periods up to 6 months. Considerable differences were noted in the pitting characteristics between the areas inside and of free, exposed surfaces. Pitting corrosion within the crevices tended to proceed nearly 25 times faster than in free, exposed areas, and growth of these pits was almost linearly dependent on the time of immersion. The location of pit formation was quite random although slightly more probability of formation was suspected at the base metal-to-cladding boundaries, while no clear dependence to the width of crevice opening was obtained within the range tested. For a typical BWR water environment, with dissolved oxygen about 0.3 ppM, the penetration by pitting corrosion was about 240 microns after 6 months of immersion. By increasing the oxygen content of water to about 25 ppM, which corresponds to the level in steam phase of a BWR, the formation and growth of pittings have been increased remarkably as compared to the former condition. (auth)

48359 (JAERI-Memo—4020) METALLURGICAL INVESTIGATIONS ON THE CLADDING FAILURE IN THE JPDR PRESSURE VESSEL. III. EFFECT OF TEMPERATURE ON THE FATIGUE CRACK PROPAGATION IN A LOW ALLOY STEEL IN DEIONIZED WATER. Kondo, Tatsuo; Kikuyama, Toshihiko; Nagasaki, Ryukichi (Japan Atomic Energy Research Inst., Tokyo). May 1970. (In Japanese). NTIS (U. S. Sales Only).

The effects of deionized water environment on the fatigue crack propagation in ASTM A-302 grade B steel have been investigated. The experiment was carried out by means of plate-bending type testing machines connected with a recirculating corrosion testing loop system, which was specially designed to keep the water quality similar to a typical BWR condition. The propagation was followed both by the direct photographing and the electrical resistance measurement. Under the condition of constant deflection at the cycling rate of 10 cycles/min, the crack propagation was substantially faster in water environment than in the room air. The extent of the acceleration was dependent on the test temperature in the manner similar to the corrosion rate of the same material placed in the same environment. In the water with the specific electrical conductivity of 0.5 to 1 Meg-Ohm-cm and with the dissolved oxygen concentration of 3 ppM, the propagation was accelerated by the factor of 3 to 4 at 90°C and 10 cycles/min. The feature of the morphology near the fracture surfaces was such that the cracks formed in water were accompanied by much less plastic deformation as compared to the case of the room air, and that more frequent branching of the cracks was apparent in the former case. The metallographic examination of the fatigued materials revealed that the cracks formed in water were partially intergranular, while those formed in the air under the same mechanical conditions were predominantly transgranular. The discussion is extended to the importance of fatigue testing in high temperature deionized water. (auth)

48360 (JAERI-Memo-4022) METALLURGICAL INVESTIGATIONS ON THE CLADDING FAILURE IN JPDR PRESSURE VESSEL. V. THE EFFECT OF FREQUENCY OF LOADING ON THE FATIGUE CRACK PROPAGATION OF A LOW ALLOY STEEL IN HIGH TEMPERATURE, DEIONIZED WATER. Kondo, Tatsuo; Kikuyama, Toshihiko; Nakajima, Hajime; Shindo, Masami; Nagasaki, Ryukichi (Japan Atomic Energy Research Inst., Tokyo). May 1970. (In Japanese). NTIS (U. S. Sales Only).

In evaluating the effects of high temperature deionized water environment on the fatigue-crack propagation in ASTM A-302 grade B Steel, an experimental apparatus has been constructed, and the first-step experiments for the effects of cyclic loading frequency on the fatigue crack propagation have been conducted. The apparatus consists of a stainless steel recirculating autoclave system and ±10 ton push-pull fatigue testing unit. The specimens used were prepared with partial stainless steel weld-overlay cladding, through which a couple of sharp notches were provided by means of bending-fatigue operation, a technique specially established for this purpose. Such a close simulation was needed to provide for the crevice corrosion effect in high-purity water. At 200°C in the BWR-simulated deionized water the crack propagation was accelerated by a factor of 2.5 at the frequency of 10 cycles/min as compared to the case of the room temperature air environment. The trend was nearly independent of the strain range within the range tested, but was rather sensitive to the loading frequency. In 200°C water the maximum acceleration of factor 4 was obtained at 1 to 3 cycles/min, while as the loading frequency was reduced below 0.5 cycles/min, the crack propagation tended to intermittently stagnate, and, accordingly, the fatigue life was extended. Such a tendency of stagnation is suspected to be shifted to high frequency ranges as the testing temperature is shifted. It is suggested that the very low cyclic frequency and high temperature in the practical nuclear reactor services might provide much more probability of stagnating fatigue cracks due to increased corrosion tendency of the water. It is suggested that the stagnation is related to the pitting corrosion in the crevices associated with the cracks. (auth) (Japan)

48361 (LBL-806) CORROSION RESISTANCE OF TRIP STEELS. Baghdasarian, Ara J. (California Univ., Berkeley. Lawrence Berkeley Lab.). May 1972. Contract W-7405-eng-48. 62p. Dep. NTIS.

Studies were undertaken to gain information about the general and pitting corrosion behavior of certain metastable austenitic steels known as TRIP steels, using a potentiodynamic polarization technique. It was found that partial transformation of austenitic TRIP steels to martensite does not have a significant effect on their corrosion resistance. TRIP steels containing molybdenum showed better resistance to pitting attack than widely used commercial stainless steels. For example, in artificial seawater, a 13Cr−7Ni−4Mo−0.25C TRIP steel had better pitting resistance than type 316 stainless steel. Finally it was found that the small amounts of P, S, Si, and Mn that are normally present in commercial steels did not effectively alter the excellent corrosion behavior of TRIP steels. (auth)

48362 (RFP-1868) LITERATURE SURVEY OF CORROSION INHIBITORS FOR RECIRCULATING COOLING WATER CORROSION INHIBITION. Briggs, John L. (Dow Chemical Co., Golden, Colo. Rocky Flats Div.). 7 Jul 1972. Contract AT(29-1)-1106. 14p. Dep. NTIS.

A literature survey was conducted to provide information concerning the chemical treatment of cooling water. Special emphasis was on the inhibition of metallic corrosion in open, recirculating cooling water systems. The mechanism, effectiveness, performance, and potential use of several commonly used anodic corrosion inhibitors are described. (auth)

48363 SELF-DISSOLUTION OF $Al_{50}Ni-_{50-x}Me_x$ ALLOYS IN SOLUTIONS OF ALKALI. Aleykina, S. M.; Marshakov, I. K.; Fasman, A. B.; Vovresyuk, I. V. Zashch. Metal.; 6: No. 6, 691-4(1970). (In Russian).

The corrosion behavior of cast ternary Al−Ni−Me alloys (Me = V, Nb, Ta, Zr) was studied in 0.1 to 2.5N NaOH. Corrosion damage was found largely to be caused by preferential dissolution of the β-phase; γ-phase and aluminides of alloying metals suffered marked damage only in strong (2.5N) solutions. Increase in temperature and alkali concentration intensified corrosion in all cases. (Referativnyi Zh.)

48364 EFFECT OF HEAT TREATMENT ON THE CORROSION RESISTANCE OF NICKEL-MOLYBDENUM ALLOYS. Lisogor, A. I.; Bogacheva, N. A.; Solovkova, N. S. (Inst. of General and Inorganic Chemistry, Kiev). Ukr. Khim. Zh.; 38: No. 2, 212-15(Feb 1972). (In Russian).

The influence of the thermal history of Ni−Mo alloys containing 30% Mo on their corrosion resistance was studied by weight and potentiostatic methods. The results showed that the annealing temperature had little effect on the corrosion rate in 10% HCl. However, the character of the corrosive attack was a function of the annealing temperature. When tempered at 600 to 750°C, alloys were susceptible to intercrystalline corrosion which was associated with the emergence of stress along grain boundaries as a result of the separation of the intermetallic compound Ni_4Mo. (tr-auth)

48365 SODIUM CORROSION AND MASS TRANSFER ANALYSIS WITH AN ION PROBE MASS SPECTROMETER. Berkey, E.; Sweeney, G. G.; Hickam, W. M. (Westinghouse Research Labs., Pittsburgh). Nucl. Technol.; 16: No. 1, 263-77(Oct 1972).

The initial application of ion probe mass spectrometry to the characterization of samples from an experimental sodium mass transfer loop has been made. The technique can be used in multielement analyses from H to U at parts per million sensitivities with a spatial resolution of about 1 micron. Results of analyses of hot leg samples from a 10,000 hour/low oxygen loop reveal significant concentration changes over the depleted zone and confirm extensive loss of carbon. Results of analyses of cold leg deposits from the same loop show the presence of occluded metallic sodium and a small component of oxides, in addition to numerous other constituents. Concentration profiles in the deposits indicate that they are both nitrided and carburized with a major oxide layer in the interface between the deposits and the stainless steel substrate. (auth)

48366 VANADIUM BASE ALLOYS CONTAINING NIOBIUM AND TITANIUM. Laue, Hans-Jurgen Rainer; Bohm, Horst Otto; Reddemann, Bernhard Hermann (to Metallgesellschaft Aktiengesellschaft). U. S. Patent 3,674,470. 4 Jul 1972. Filed 8 Aug 1968.

High corrosion resistant alloys composed of 12 to 25%, preferably, 14 to 16% of niobium, 1 to less than 3%, preferably, 2.6 to 2.9%, of titanium, up to $\frac{1}{2}$ of the titanium being replaceable with zirconium and/or hafnium, not more than 1% of carbon, nitrogen and oxygen, up to 1.5% of silicon, and the remainder vanadium were developed. The alloys remain stable over long periods of time at temperatures between 500 and 800°C and are used as construction materials in nuclear reactors, especially those having cooling systems using molten alkali metals, space vehicles, and chemical apparatus. (Official Gazette)

48367 STRUCTURE OF SODIUM CORROSION DEPOSITS AND THEIR EFFECT ON HEAT TRANSFER COEFFICIENTS. Ray, W. E.; Miller, R. L.; Schrock, S. L.; Whitlow, G. A. (Westinghouse Nuclear Energy Systems, Madison, Pa.). Nucl. Technol.; 16: No. 1, 249-62(Oct 1972).

Sodium mass transfer deposits up to 10 mils in thickness have been observed on Type 304 stainless steel intermediate heat exchangers (IHX) cold leg surfaces after 10,000 hours of steady-state operation. The magnitude of deposition has been shown to be time and location dependent. Deposit thicknesses will continue to grow over the 40 year design life of the IHX, with the only mechanisms which may tend to limit deposit thicknesses being flow shear forces at the wall and stresses induced by thermal transients. Some of the physical and chemical properties of typical mass transfer deposits collected from primary and secondary sodium systems have been characterized. The composition was found to be highly dependent on location in the system, and the first materials to precipitate were rich in chromium, whereas deposits located further downstream contained large amounts of manganese. A 50°F drop in temperature was normally sufficient to initiate precipitation of these deposits. Interpreted in terms of the reactor system, this would indicate that the step change in temperature, encountered when by-pass streams are mixed with core coolant sodium, may be large enough to initiate deposition in the isothermal hot leg piping. In addition to the metallic constituents, carbon concentrations as high as 2% have been measured in the deposits together with significant quantities of nitrogen and oxygen. Since carbides, oxides, and nitrides typically exhibit lower thermal conductivities than metallic elements or alloys, it was expected that the deposits would represent a significant heat transfer resistance. Experiments were designed to measure the degradation in the heat transfer coefficient due to corrosion product deposition in small sodium loop systems. Application of these results to IHX and steam generator designs indicated a 9% reduction in heat transfer. (auth)

48368 SPREADING AND AGGRESSIVE EFFECTS BY NICKEL-BASE BRAZING FILLER METALS ON THE ALLOY 718. Amato, I.; Baudrocco, F.; Ravizza, M. (Fiat, Turin). Weld. J. (N. Y.); 51: No. 7, 341s-5s(Jul 1972).

The spreading and the aggressive effects of three nickel-base brazing filler metals on the Alloy 718 were determined. The three brazing filler metals are the ASTM alloy BNi-5, the Ni-Mn-Si-Cu alloy and the ASTM alloy BNi-7. Brazing was carried out under a vacuum of 10^{-4} torr in the temperature and time range of each brazing alloy. Experimental results showed poor spreading for the ASTM alloy BNi-5 and acceptable spreading for the Ni-Mn-Si-Cu and the ASTM-BNi-7 alloys. The aggressive effects are weak for ASTM BNi-5 and Ni-Mn-Si-Cu alloys, but are strong for the ASTM alloy BNi-7. (auth)

48369 COMPATIBILITY OF BRAZED JOINTS WITH POTASSIUM AND VACUUM. Hendricks, J. W.; Cole, N. C.; Slaughter, G. M. (Oak Ridge National Lab., Tenn.). Weld. J. (N. Y.); 51: No. 7, 329s-36s(Jul 1972).

Results of investigation of metals for comptability with K and vacuum conditions are reported. All the brazing filler metals tested at 1700°F withstood the stated test environments without any adverse effects. Of the alloys tested at 1500°F, one (the Ti-28 wt % V-4 wt % Be alloy) performed satisfactorily under all the test conditions. In the Ti—Zr—Fe and Zr—Nb—Be systems, the integrity of the brazes was severely diminished after testing at 1500°F in argon, vacuum, and potassium. The specimens brazed with Ti—48 wt % Zr—4 wt % Be and Ti—46 wt % Zr—4 wt % V—4 wt % Be filler metals were severely degraded by the test environments at 1500°F for 1000 h. However, because of their excellent ability to braze most refractory metals, these last-mentioned compositions are very attractive for lower temperature applications. (J.R.D.)

48370 DEVELOPMENTS IN VACUUM BRAZE COATING OF AERO-ENGINE NOZZLE GUIDE VANES. Malcolm, Lindsay J. (Edwards High Vacuum Ltd., Sussex, Eng.). Welding J. (N. Y.); 51: No. 7, 483-8(Jul 1972).

The application of a vacuum braze coating as an integral part of a crack repair scheme has proved to be a worthwhile technique. The choice of a single alloy for use on both cobalt and nickel-base alloy vanes was perhaps optimistic. Experience has shown that the coating alloy should be chosen with both case metal chemistry and particular operating conditions in mind. The CM60 Ni-Cr-Si alloy has proved to be of particular benefit on C1023 nickel alloy vanes where it has exhibited good resistance to hot corrosion and thus effectively reduced mid-chord cracking. It has also shown sufficiently good oxidation resistance to reduce surface degradation in many instances and thus minimize grain-boundary cracking effects at the trailing edge sections of the vanes. The use of the CM60 alloy on the cobalt alloy (X40) vane has been justified in that, in most instances, the coating has undoubtedly protected the vanes from surface erosion and oxidation. In some instances however, the alloy has shown to possess an insufficiently high remelt temperature to withstand the extreme operating temperatures that these vanes at times experience. The Ni-Cr-Si alloy was found to cause no harmful reaction when welded with either electron beam or gas tungsten-arc and should thus present no problems if coated vanes are later re-airfoiled. (auth)

Preparation and Fabrication

Refer also to abstracts 48326, 48343, 48352, and 49725.

48371 (CISE-R-292) CHARACTERIZATION AND CONTROL OF SOME URANIUM TUBES COEXTRUDED WITH ZIRCALOY CLADDING. Scaroni, A. (Centro Informazioni Studi Esperienze, Milan (Italy)). Dec 1969. 71p. INIS.
Declassified 1971.

The activities performed on the fabrication and evaluation of some metallic uranium fuel tubes with Zircaloy-2 cladding coextruded by Nuclear Metals Inc. on the basis of CISE specifications are described. The work is a basic part of the experimental program, sponsored by EURATOM and CNEN, for the development of the metallic CIRENE fuel element. After the description of the fabrication process, an account is given of the measurements and tests carried out at NMI, at SORIN, and at CISE for the control of the initial specifications and for the characterization of the products. Some final notes, concerning both the work described and other relevant activities, are added. (INIS)

48372 (HW-76347) OBSERVATIONS ON PRODUCING DUCTILE ZIRCALOY-2 STRIP AND SHEET. O'Keefe, D. P. (General Electric Co., Richland, Wash. Hanford Atomic Products Operation). 11 Jan 1963. 7p. Dep. NTIS.

Procedures used successfully for the production of Zircaloy-2 strip and sheet in small lots are described. Fabrication procedures with extrusion as the primary reduction from ingot followed by rolling have been found to produce very ductile sheet. The extrusion method controls texturing, which affects bend ductility. Heterogeneous microstructure is to be avoided because of fatigue strength requirements and because of orange peeling that will result if the zone of critical strain is near the surface. (P.C.H.)

48373 (MLM-1926) HYDROFORMING METAL FOILS. Wyder, W. C. (Mound Lab., Miamisburg, Ohio). 26 Jun 1972. Contract AT-33-1-GEN-53. 16p. Dep. NTIS.

The special technique required to deep draw thin metal foils, using the hydroform process (technically known as rubber-diaphragm forming) is described. Molybdenum foil, 0.002 in. thick, and Mo-46 wt % Re alloy foil, 0.005 in. thick, were both hydroformed into hemispherical shells. The foil blanks were formed while sandwiched between two relatively thick mild steel blanks called waster sheets. The waster sheets were used only as an aid to the forming operation and were discarded afterwards. (auth)

48374 (RDT-M-3-28-T(5-72)) AUSTENITIC STAINLESS STEEL TUBING FOR LMFBR CORE COMPONENTS. (Division of Reactor Development and Technology (AEC), Washington, D. C.). May 1972. 25p. RSO.

A standard prescribing requirements for austenitic stainless steel tubing for LMFBR core components and associated applications is presented. (J.R.D.)

48375 (RDT-M-7-3-T(8-72)) STAINLESS STEEL BARS AND SHAPES (ASME SA-479 WITH ADDITIONAL REQUIREMENTS). (Division of Reactor Development and Technology (AEC), Washington, D. C.). Aug 1972. 9p.

A standard prescribing requirements for stainless bars and shapes (ASME SA-479 with additional requirements) for nuclear and associated applications is presented. This standard supersedes RDT M 7-3T, dated July 1971. (J.R.D.)

48376 (RFP-1816) ISOTROPIC HIGH STRENGTH BERYLLIUM. Floyd, Dennis R. (Dow Chemical Co., Golden, Colo. Rocky Flats Div.). 6 Jul 1972. Contract AT(29-1)-1106. 13p. Dep. NTIS.

A process for making high strength beryllium by a hot-pressing, extrusion, and upset-forging route is described. Isotropic compressive yield strengths of greater than 100,000 psi were achieved by forward-extruding to a 4 to 1 reduction in area at 1300°F followed by upset-forging at temperatures between 1000 and 1200°F and reductions in height between 40 and 60%. Both tensile and compressive data for hot pressed, hot pressed and extruded, and hot pressed, extruded, and forged beryllium are presented and discussed. (auth)

48377 (RFP-1852) FRICTION WELDING OF ALUMINUM AND STAINLESS STEEL. Brandon, Eldon (Dow Chemical Co., Golden, Colo. Rocky Flats Div.). 17 Jul 1972. Contract AT-(29-1)-1106. 10p. Dep. NTIS.

Studies were made of friction-welded cylindrical coupons of aluminum (5083 and 7039) and stainless steel (Type-304L) to check the applicability of friction welding at Rocky Flats Plant. After sectioning the coupons for macroexamination and tensile testing, the effects of various welding parameters were determined. The criteria for evaluation included mechanical properties, upset (change in length), and flash. Approximate welding parameters were derived and are reported. The resultant welding flash was approximately twice the original wall thickness. The upset values were 0.7 centimeters in the 0.65-centimeter wall stainless steel cylinders, and 1.0 centimeters in the 1.25-centimeter wall aluminum cylinders. All 5083 tensile coupons failed in the heat-affected zone; and all 7039 tensiles failed in the base metal. Failures in all three locations were encountered with the stainless steel (Type-304L). Because of the geometry of the as-welded joint, friction-weld processes are not applicable for current production at Rocky Flats. (auth)

48378 BRAZING METHOD. Caperan, Francois; Gillet, Rene (to Commissariat a l'Energie Atomique). French Patent 2,070,480. 16 Aug 1971. Filed 5 Dec 1969. (In French).

A method for brazing a semi-cylindrical metal window onto a cylindrical metal piece under vacuum, such that the brazed joint is gas-tight with respect to He, is described. This method is used in the construction of particle accelerators for the welding of light metal windows (transparent to particles) onto the cylindrical body of the accelerators. A filament of the brazing material is positioned between the cylindrical support and the window and along the edge of the window. The window is maintained against the support by a metallic band. This band is maintained under tension in order to facilitate the contact between the window and the support when the brazing filament melts. The assembly is placed in an evacuated enclosure heated by induction. (France)

48379 METHOD OF JOINING CERTAIN METALS. Hershenson, Lawrence H. (to United States Atomic Energy Commission). U. S. Patent 3,657,801. 25 Apr 1972. Filed 22 Apr 1970.

A method of forming strong and thermally durable bonds between aluminum and titanium, tungsten or SiGe alloys and between titanium and either tungsten or SiGe alloys for use in thermoelectric generators is described. (Official Gazette)

48380 CRUCIBLE COATING FOR PREPARATION OF U AND Pu ALLOYS CONTAINING Zr OR Hf. Harbur, Delbert R.; Anderson, John W.; Money, Richard K. (to United States Atomic Energy Commission). U. S. Patent 3,660,075. 2 May 1972. Filed 16 Oct 1969.

A method is described for limiting adverse oxygen contamination in the preparation of uranium and plutonium alloys containing zirconium or hafnium, in which the metals are melted and alloyed in a graphite crucible coated with niobium carbide or yttrium oxide. (Official Gazette)

48381 PLUTONIUM PRODUCTION. Conner, William V. (to United States Atomic Energy Commission). U. S. Patent 3,666,443. 30 May 1972. Filed 5 Nov 1969.

The process is described for the reduction of plutonium fluorides to plutonium metal. The process consists of heating to the reaction temperature a mixture of plutonium fluorides and calcium metal together with an additive selected from the group consisting of magnesium fluoride and calcium chloride, allowing the mixture to react to form a plutonium metal button, and physically separating the plutonium metal button from the reaction slag. (Official Gazette)

48382 THERMOMECHANICAL PROCESSING OF NICKEL-BASE ALLOYS. Kear, B. H.; Oblak, J. M.; Owczarski, W. A. J. Metals; 24: No. 6, 25-32(Jun 1972).

A review is presented on the impressive progress that has been made in the TMT processing of γ' precipitation hardened nickel-base alloys. The most striking advances in the state of the art have been made in the hot working area, where the conditions have been specified for obtaining superplastic-type behavior in several alloys by conventional forging, and for its utilization in the fabrication of fairly complex, massive shapes to very close tolerances by high-ductility forging. In addition to this, significant progress has been made in the warm working area in that it has been shown that the formation of a polygonized dislocation substructure by carefully controlled warm working can result in definite improvements in such mechanical properties as yield strength, ultimate strength, and low and high cycle fatigue strengths, without serious losses in ductility and in creep resistance, at least up to 1400°F. (auth)

48383 PREPARATION OF NON-NOBLE METALS (Li, Ca, Sr, Ba, Am, Cf) BY REDUCTION OF THEIR OXIDES AND FLUORIDES WITH HYDROGEN. Berndt, Uwe; Erdmann, Bernhard; Keller, Cornelius (Kernforschungszentrum, Karlsruhe, Ger.). Angew. Chem. Int. Ed. Engl.; 11: No. 6, 515-16(Jun 1972).

A method is proposed for the preparation of non-noble metals from their oxides, fluorides, or other suitable compounds by reduction with hydrogen. In other words, if a very finely powdered mixture of metal oxide (Li_2O, CaO, SrO, BaO, $AmO_{1.5}$, or $CfO_{1.5}$) and noble metal is heated above 1100℃ in a stream of pure H_2, the corresponding intermetallic phase is obtained in very pure form. If these phases are further heated in a high vacuum (10^{-5} to 10^{-6} torr), the readily volatile components (Li, Ca, Sr, Ba, Am, Cf) evaporate and can be isolated by condensation. The noble metal functions wholly as a catalyst for the reduction of the metal oxide to metal by hydrogen. The metals isolated by evaporation were identified by x-ray diffraction and by chemical analysis. (P.C.H.)

48384 MELTING OF REFRACTORY METALS IN VACUUM. Durand, R. (Ugine-Kuhlmann, Brignoud, France. Ugine-Kuhlmann, Paris); Ailloud, P.; Langeron, J. P. Rev. Int. Hautes Temp. Refract.; 9: No. 1, 77-92(Jan 1972). (In French).

From Meeting of the French Society of High Temperatures; Clermont-Ferrand, France (22 Oct 1970). See CONF-701028.

Recent progress in fusion techniques enable large quantities of metals such as titanium, zirconium, hafnium, vanadium, and niobium to be prepared. The mechanical properties and transformation characteristics of these metals are very sensitive to the presence of metalloid impurities. Electric arc melting is a rapid process in which there is very little interaction between the melting metal and the atmosphere; variations in the chemical composition are thus not very significant. In contrast, electron-beam melting enables the applied electric power and the rate of melting to be separated. Certain elements can be prepared in a very pure state by this method. A knowledge of the purification kinetics during vacuum melting assists the choice of the most suitable operating conditions. These phenomena are illustrated with examples. (France)

48385 RADIATION RESISTANT WELD METAL FOR FABRICATING A533-B NUCLEAR REACTOR VESSELS. Hawthorne, J. R. (Naval Research Lab., Washington, D. C.). Weld. J. (N. Y.); 51: No. 7, 369s-75s(Jul 1972).

A Mn-Mo-Ni filler metal was prepared for improved radiation embrittlement resistance. The upgraded filler metal has special application to the submerged arc welding of A533-B nuclear reactor pressure vessels. High resistance to radiation embrittlement was demonstrated by a 6-in. thick test weld and was achieved through selective restrictions on the content of certain impurity elements, primarily copper (0.10% maximum as-deposited) and phosphorus (0.010% maximum as-deposited). To help achieve a low copper content, a non-copper clad filler metal was used. The copper and phosphorus contents of the test weld deposit were 0.05% and 0.010% respectively. Preirradiation tensile properties satisfied A533-B Class 2 specification requirements. The Charpy-V 30 ft-lb transition was −50°F and approximated well the drop weight nil-ductility transition (NDT), −60°F. Essentially no embrittlement of the weld metal was observed following an expsoure of 2.7×10^{19} n/cm^2 >1 MeV at 550°F. This exposure condition is comparable to that estimated for many operating reactor vessels at end-of-life. Results for a factor of ten higher fluence (2.5×10^{20} n/cm^2) clearly denoted a superior 550°F radiation resistance. The Charpy-V 30 ft-lb transition remained below 200°F and the Charpy-V shelf level remained above 80 ft-lb. Projections of high fluence weld properties by Ratio Analysis Diagram (RAD) procedures indicated a nonsusceptibility of 12 in. thick deposits of this quality to plane strain fracture. Weld heat-affected zone performance was also explored for the case of controlled composition (radiation resistant) plate. Resistance of the heat-affected zone to embrittlement by 2.7×10^{19} n/cm^2 was found equal to that of the controlled composition weld deposit and superior to that of the base metal. Observations clearly signify the need for restricting the impurity content of welds and plates for critical nuclear service applications. (auth)

Properties, Structure, and Phase Studies

Refer also to abstracts 47988, 47994, 48331, 48347, 48482, 48485, 49718, 49726, 49747, 49749, and 49763.

48386 (HEDL-SA-329) FATIGUE-CRACK GROWTH IN TYPE 304 STAINLESS STEEL WELDMENTS AT ELEVATED TEMPERATURE. James, Lee A. (Westinghouse Hanford Co., Richland, Wash. (USA)). 3 Dec 1971. Contract AT(45-1)-2170. 22p. (CONF-720622-1). Dep. NTIS.

From Symposium on fatigue at elevated temperatures; Storrs, CT. (18 Jun 1972).

The propagation of fatigue-cracks in gas-tungsten-arc weldments of Type 304 stainless steel was studied at 75°F (24°C) and 1000°F (538°C). It was found that the crack growth rate for cracks propagating normal to the direction of welding decreased as the crack approached the weld, and then increased as the crack grew through the weld and out the other side. It is postulated that this is due to the residual stresses produced during the welding process, and that metallurgical variations in the weldment play a minor role. (auth)

48387 (HEDL-TME-72-75) EFFECT OF CHEMISTRY VARIATIONS ON THE RECRYSTALLIZATION TEMPERATURE OF 20 PERCENT COLD WORKED TYPE 316 STAINLESS STEEL. Paxton, M. M.; Straalsund, J. L. (Hanford Engineering Development Lab., Richland, Wash.). Jun 1972. Contract AT(45-1)-2170. 33p. Dep. NTIS.

The effects of composition on the one-hour recrystallization temperature of 20% cold worked Type 316 stainless steel were determined by using hardness measurements. The studies were performed on 45 different alloys, based on Type 316 stainless steel; compositional variations were in carbon, nitrogen, phosphorus, sulfur, boron, manganese, copper, silicon, molybdenum, cobalt, chromium, and nickel. Over certain composition limits for a single alloy element it was found that the recrystallization temperature varied linearly with composition. Assuming no interaction parameters the recrystallization temperature can be calculated by a simple summation. A multiple linear regression computer code yielded the following equation: Recrystallization temperature = 1583°F + 1396 (% Carbon) + 19.2 (% Molybdenum) + 35846 (% Boron) − 8.6 (% Chromium) + 240 (% Nitrogen). Utilizing this equation and the composition limits set in RDT Standard E 13-8, the one hour recrystallization temperature of 20% cold worked cladding can range from a low of 1520°F to a high of 1620°F. (auth)

48388 (LBL-827) LOW-TEMPERATURE HEAT CAPACITY OF CERIUM METAL. Conway, Mary MacIvor (California Univ., Berkeley. Lawrence Berkeley Lab.). May 1972. Contract W-7405-eng-48. 96p. Dep. NTIS.

Thesis.

The heat capacities of mixtures of the α and β phases of Ce metal were measured between 0.08 and 24°K at zero pressure and in zero field. Two were also measured between 0.4 and 24°K in fields of up to 60.5 kOe. The heat capacities of the pure phases were extrapolated from this data. α Ce has a γ of 22 mJ/mole · K^2, showing the expected large f contribution, and a θ of 125°K. The low temperature heat capacity of β Ce is field independent to 60.5 kOe. It can be represented by a linear term with γ = 54 mJ/mole K^2 and a T^3 term an order of magnitude larger than that expected from the lattice contribution. Existing theories seem inadequate to explain the large size of the former and the field independence of the latter. The entropy associated with the 12.5°K ordering peak shows it to involve only half the sites of the dhcp β phase. (auth)

48389 (MLM-CF-67-5-464) AUTORADIOGRAPHIC MEASUREMENT OF THE PENETRATION OF TRITIUM IN STAINLESS STEEL. Braun, J. D.; Downs, G. L. (Mound Lab., Miamisburg, Ohio). 1962. 24p. Dep. NTIS.

Penetration of tritium into Type 304 ELC stainless steel was measured by autoradiographic techniques, and these data were correlated with concentration-penetration data obtained by radiocounting. Experimental techniques for preparation of the samples and techniques used for obtaining the autoradiographs are described. Photomicrographs are presented illustrating these techniques and showing the location and penetration depth of tritium in the samples studied. (auth)

48390 (N-72-20598) NERVA MATERIALS DEVELOPMENT. Quarterly Report, July-September 1970. Mandell, B. (Aerojet Nuclear Systems Co., Sacramento, Calif.). Nov 1970. Contract SNP-1. 195p. (NASA-CR-125889). NTIS.

Materials development topics include: development of analysis techniques to adjust heterogeneous data; determination of thermal conductivity for AISI 347 stainless steel and elastic moduli and Poisson's ratio for Inconel 718 and Ti-5Al-2.5 Sn; embrittlement effects of 1400 psi gaseous hydrogen for alloy 718 and Ti-5Al-2.5 Sn; cryogenic radiation damage of Ti-5Al-2.5 Sn; and evaluation of impregnation, and fabric materials for optimum fibrous graphite properties. Component support topics include: tensile design allowable development of Ti-5Al-2.5 Sn for turbopump applications; evaluation of fatigue, fracture toughness, and stress corrosion properties of AA 7039-T63 for pressure vessel applications; development of AISI 347 sheet tensile and creep properties for nozzle applications; evaluation of orbital weld techniques for aluminum line fabrication; material selection of shield materials; development of high load friction and wear properties of hard chrome/gold plate combinations; and evaluation of weld processes for NASS duct coolant channel fabrication. (auth) (STAR)

48391 (NAA-SR-Memo-9344) HIGH TEMPERATURE ULTRA-HIGH VACUUM SELF-WELD TESTING. Interim Report No. 2. Johnson, G. D.; Kellogg, L. G. (Atomics International, Canoga Park, Calif.). 19 Dec 1963. Contract AT-11-1-GEN-8. 44p. Dep. NTIS.

Declassified 8 Nov 1971.

Various material combinations were evaluated in high-temperature, ultra-high vacuum chambers in order to determine the tendency to self-weld. The combinations evaluated were mainly ceramic and metallic couples. The tests were conducted in the temperature range of 700 to 1300°F, with times up to 3400 hours. The combinations, in which the adhesion force was immeasurable, were assigned an adhesion force equal to the accuracy of measurement (0.1 lb). The resulting average value of adhesion for the 65 tests is 0.71 lbs. The data indicate that in order to minimize adhesion, some contaminant film must be placed between the two surfaces. The equipment and procedure used are discussed in the first interim report. The results of the first twenty-one combinations are also presented in the first interim report. A new method of obtaining adhesion data has been incorporated since the first interim report; this is illustrated. (J.R.D.)

48392 (NAA-SR-Memo-10385) REPORT OF THE THERMAL-VACUUM TEST OF PYRAD 1000 HIGH TEMPERATURE WIRE FOR 1000 HOURS AT 1100°F. Southern, A.; Nowell, P. (Atomics International, Canoga Park, Calif.). 27 Aug 1964. Contract AT-11-1-GEN-8. 11p. Dep. NTIS.

Single and double conductor shielded specimens of Pyrad 1000 high temperature wire, half the quantity of which were coated with Fosterseal, were subjected to a 1000 hours environmental test at 1100°F and an average pressure of 5×10^{-6} torr. Insulation resistance measurements were made of all possible combinations of conductors and shields throughout the environmental exposure. Insulation resistance characteristics of Fosterseal-coated wire degraded rapidly from 10^{10} ohms down to 10^7 ohms or less and eventually dropped to 10^3 to 10^4 ohms between shields and between conductors and inner shields, respectively. The degradation was permanent, i.e., insulation resistances recovered relatively little when the wire specimens were returned to an ambient environment. The specimens with no Fosterseal coatings degraded, but generally only from 10^{10} to 10^7 ohms, with 1.5×10^6 ohms being the worst case. (auth)

48393 (ORNL-tr-2608) THERMODYNAMIC CALCULATIONS CONCERNING THE NATURE OF GUINIER-PRESTON ZONES IN ALUMINUM-COPPER ALLOYS. Meijering, J. L. Translated for Oak Ridge National Lab., Tenn., from Rev. Met. (Paris); 49: No. 12, 907-10(1952). 10p. Dep. NTIS.

The mixing energy of the fcc phase and the metastable solubility were calculated for Al-Cu alloys. The calculations demonstrated that a priori, a segregation of homogeneous Al-Cu alloys supersaturated in two disordered fcc phases when the formation of a new structure (θ, θ') would be prevented by nucleation difficulties should be expected. From the thermodynamics standpoint, the formation of Guinier-Preston zones with essentially the same structure as that of the matrix thus is possible and perfectly normal. At room temperature the metastable solubility, which evidently refers to a macroscopic precipitate, is very small. For the composition of the second phase, the calculation resulted in about 55 at.% Cu, but this concentration was quite variable with the interpolation method. The value of the second derivative of the free energy d^2F/dx^2 was also calculated. It was found to be positive even at 0°C and at a concentration of 5.7 wt% Cu. Thus, it can be said that according to the calculation it is not probable that negative diffusion (against the concentration gradient) plays a role in the hardening of Al-Cu alloys, which does not seem to contradict aging tests. (P.C.H.)

48394 (RD/B/N-2210) MEASUREMENT OF CREEP STRAINS IN STRUCTURAL COMPONENTS. Mitchell, D. H.; Procter, E. (Central Electricity Generating Board, Berkeley (England). Berkeley Nuclear Labs.). Feb 1972. 21p. Dep. NTIS (U. S. Sales Only).

Techniques available or being developed for measuring creep strains in structural components are discussed. They are divided into two categories: those for making overall distortion and surface measurements off-load, i.e., "before and after" techniques, and those for measurements on-load, at plant operating temperatures. Reference is made to creep strain measurements during laboratory tests. Comparisons were made between on-load and off-load measurements over a period of 3,000 hours, on a mild steel pressure vessel tested at 430°C. Results of long term stability tests on electric resistance and capacitive strain gauges are given. A number of gauge systems currently being developed for high temperature purposes are outlined. It was concluded that off-load methods are satisfactory for distortion measurements and surface strain measurements in certain cases. Also, on-load measurements during laboratory tests can be made with electric resistance strain gauges provided certain precautions are taken. (auth)

48395 (RD/B/N-2321) STATIC ADHESION OF EN58B STAINLESS STEEL IN CARBON DIOXIDE BETWEEN 450°C AND 750°C. Rowe, M. D. (Central Electricity Generating Board, Berkeley (England). Berkeley Nuclear Labs.). May 1972. 11p. Dep. NTIS (U. S. Sales Only).

Metallic surfaces in contact in an oxidising environment may develop a common oxide film which causes a bond between the components. Static adhesion is the accepted term to describe this process. An experiment is described where EN58B stainless steel surfaces were lightly loaded together for 250 hours at temperatures from 450°C to 750°C. Static adhesion bond strengths were measured at the end of the test period in the hot and cold condition, both in shear and in tension. It was shown that hot testing gave more repeatable results and that shear strength was higher than tensile strength. It is suggested that the cold tensile method of testing would lead to low values of interfacial bond strength. (auth)

48396 (RD/B/N-2330) DIFFUSION OF NIOBIUM IN 20/25/Nb STAINLESS STEEL. Smith, A. F. (Central Electricity Generating Board, Berkeley (England). Berkeley Nuclear Labs.). Jun 1972. 13p. Dep. NTIS (U. S. Sales Only).

The diffusion of ^{95}Nb was measured in 20/15/Nb stainless steel over the temperature range 500–1250°C. Lattice diffusion can be described by: $D_L = 2.0^{+4.2}_{-0.9} \exp[-(64.2 \pm 1.9/RT)]$ cm^2 sec^{-1} over the temperature range 750 to 1250°C. Grain boundary diffusion over the temperature range 550 to 760°C can be represented by: $\delta D_B = (1.1^{+26}_{-6}) \times 10^{-3} \exp[(-57.6 \pm 2.9/RT)]$ cm^3 sec^{-1}. No evidence was found for dislocation-enhanced volume diffusion of niobium. (auth)

48397 (RDT-C-7-7-T(8-72)) THERMOCOUPLE MATERIALS, PLATINUM, AND PLATINUM 10 PERCENT RHODIUM WIRES, NONINSULATED REFERENCE AND STANDARD GRADES. (Division of Reactor Development and Technology (AEC), Washington, D. C.). Aug 1972. 9p. RSO.

A standard prescribing requirements for thermocouple materials, platinum and platinum wires, noninsulated reference and standard grades for nuclear and associated applications is presented. (J.R.D.)

48398 (UJV-2838-M) CRYSTALLOGRAPHIC STRUCTURE OF ZIRCONIUM AND THE SYSTEMS Zr–H, Zr–O. Kocik, J.; Saxl, I. (Ceskoslovenska Akademie Ved, Rez. Ustav Jaderneho Vyzkumu). 1972. 116p. (In Czech). Dep. NTIS (U. S. Sales Only).

Crystallographic data and related structural phenomena of zirconium and its selected alloys and individual phases in the Zr–H and Zr–O systems were critically reviewed and analyzed from literature data to 1971. Phase diagrams and transformations, stability of phases, alloying and impurity effects, mutual solubility in the metal-gas systems, and orientation relationships between phases and allotropic modifications and in some cases also metallographic aspects are covered. 173 references. (auth)

48399 ESTIMATION OF DENSITIES OF STATE OF SILVER IN α-SOLID SOLUTIONS OF SILVER WITH GALLIUM, INDIUM, GERMANIUM, AND TIN BASED ON THERMODYNAMIC INVESTIGATIONS BY MEANS OF SOLID STATE GALVANIC CELLS. Predel, B.; Schallner, U. (Univ., Muenster, Ger.). Z. Naturforsch.; 27a: No. 7, 1098-1108(Jul 1972). (In German).

The partial free enthalpies of formation of the binary α-solid solutions of silver with gallium, indium, germanium, and tin were determined at 1000°K from the emf of suitable solid state galvanic cells. A further evaluation of the results taking into account known enthalpies of formation yielded the complete partial and integral excess functions of these solid solutions. An analysis of the difference of the excess values of the partial free enthalpies of formation of the components showed that the lattice distortion, due to differences in atomic radii of the solid solutions studied, was not very significant. Differences in the structure between the solid solution and its components could be clearly noted only in the case of the silver–germanium solid solutions. The energetics of the alloys were determined principally by the filling of the $5s^1$ conduction band of the silver by the electrons contributed by higher-valent constituents. From the thermodynamic results the density of state of the conduction band of the silver was estimated to be smaller than 0.31 electron per atom and eV. The density of state increased with increasing concentration of the alloying component; this can be explained by a change in the Fermi surface in the silver host lattice. (auth)

48400 THERMOCHEMICAL ANALYSIS OF PHASE EQUILIBRIA IN ALLOY SYSTEMS. Rao, Mannige Vikram. Stanford, Calif.; Stanford Univ. (1972). 212p. University Microfilms Order No. 72-16,777.

Thesis.

The aim of this work is to select and develop a formalism to adequately describe interaction of metallic species in solution, develop a technique to obtain the necessary parameters for specific systems, and finally demonstrate the use of these parameters in a particular metallurgical application. The thermochemical formalism has been built around the parameter α, defined as $\alpha_{12} = [\ln\gamma_1/(1 - N_1)]_2$, with simplicity and adequacy being stressed in application to metallic systems. By expanding the partial molar excess entropy and enthalpy in power series' in composition, it is possible to deduce a form for α, $\alpha_{12} = l + a\,N_2 + (b/T) + c\,(N_2/T)$ where l, a, b, and c are related to the power series coefficients, and are constant. This equation, with $c = 0$, has been shown to fit the solubility data for several binary Ge and Si systems. The α-parameters in the Ga–As and Ga–P systems are also found to fit the proposed form, with the coefficient being composition-dependent in each case. The Fe–Cr, Fe–Ni, Cr–Ni, Pb–Sn, Ge–Si and In–Ga systems have been analyzed to obtain the appropriate α-parameters. Phase equilibria at lower temperatures, calculated using the parameters deduced from high temperature equilibria, agree very well with previous investigations, for the systems Fe–Cr and Pb–Sn. In the process of analysis, the existing In–Ga phase diagram has been shown to be incorrect, and a new one computed. The value of relatively simple thermochemical analyses has been demonstrated in the revision of the solid–liquid equilibrium diagrams in the systems Fe–Cr and B–Cu. Activities of the constituents in liquid Fe–Ni–Cr alloys have been computed using the ternary formalism, and deduced binary α-parameters. The results are in good agreement with those of the one available experimental work. Computer routines have been developed to follow the progress of freezing of binary and ternary alloys. Within the limitations of the assumptions, these routines are capable of simulating the essential features of the freezing of a casting. The use of such information in improvement of casting practice is discussed. Initial calculations for stainless steel and Inconel have been conducted, a detailed treatment not being possible at this time, due to lack of thermochemical data. (Diss. Abstr. Int., B)

48401 INITIAL AND STATIONARY POTENTIALS OF ELECTROLYTIC RHENIUM AND RHENIUM–NICKEL ALLOY. Pishikin, A. M.; Popereka, M. Ya. Zashch. Metal.; 6: No. 5, 535-7(1970). (In Russian).

The stationary potentials of alloys with a nickel content of less than 50 wt % were the same as those of rhenium, which indicated that nickel was leached from the surface during establishment of the stationary potential. (Referativnyi Zh.)

48402 ADSORPTION OF OXYGEN ON SINGLE CRYSTAL PLANES OF TUNGSTEN. Workowski, C. J. (Univ., Wroclaw). Acta Phys. Pol.; A42: No. 1, 9-18(Jul 1972).

Measurements were made on the interaction between oxygen and tungsten surfaces using the field emission microscope (FEM), at the temperature of 90°K. Special attention was paid to processes occurring on the low-index planes such as (110), (112), (111), and (013). For these planes the change of the work function versus number of oxygen doses, being a measure of the surface coverage, was determined. It was found that plots of the changes of the work function for (110) and (112) were completely different from those for (111) and (013). For (110) and (112) planes a maximum for the work function change plot was observed at intermediate coverage, i.e. before oxygen saturated the surface. Visual observations also showed striking changes in the vicinity of (110), caused by adsorption. These effects can be considered as the reconstruction process. The problem of the oxygen adsorption on tungsten has already been studied in many papers. The fact that the results obtained varied widely and were sometimes inconsistent is discussed. (auth)

48403 THERMAL CONDUCTIVITY OF THE ELEMENTS. Ho, C. Y.; Powell, R. W.; Liley, P. E. (Purdue Univ., Lafayette, Ind.). J. Phys. Chem. Ref. Data; 1: No. 2, 279-421(1972).

An abridged version of a comprehensive volume on the thermal conductivity of the elements is presented that contains recommended reference values resulting from critical evaluation, analysis, and synthesis of all the available data. Estimated values are given for those elements for which there is no thermal conductivity data available. Thus, the work provides recommended or estimated thermal conductivity values for all the elements over the full temperature ranges where experimental data are available or reliable extrapolations or estimations can be made. The results on each element are presented in both graphical and tabular forms. Summary graphs arranged by group in the periodic table are also given. (auth)

48404 FATIGUE-CRACK GROWTH IN 20 PERCENT COLD-WORKED TYPE 316 STAINLESS STEEL AT ELEVATED TEMPERATURES. James, Lee A. (Westinghouse Hanford Co., Richland, Wash.). Nucl. Technol.; 16: No. 1, 316-22 (Oct 1972).

The fatigue-crack propagation behavior of 20% cold-worked Type 316 stainless steel was characterized over the temperature range 75 to 1300°F using linear-elastic fracture mechanics. It was found that, at a given level of stress intensity factor, increasing the temperature produced a significant increase in the rate of fatigue-crack propagation. At 1000°F, decreasing the cyclic frequency tended to increase the crack growth rate. The data also suggests that, at a given temperature, the crack growth rate is slightly higher when the direction of crack extension is parallel to the rolling direction than when the crack extension is perpendicular to the rolling direction. Results of comparison with data for solution-annealed Type 316 fatigue-cycled under similar conditions indicate that, at a given temperature, cold-working increases the resistance to fatigue-crack propagation. (auth)

48405 CREEP DATA ACQUISITION AND APPLICATION TO REACTOR COMPONENT DESIGN. Ayres, D. J. (Combustion Engineering, Inc., Windsor, Conn.); Cullen, T. M. Nucl. Technol.; 16: No. 1, 287-96(Oct 1972).

A unique data acquisition and process control system designed for the generation of creep constitutive equations is described. The system is capable of measuring and recording very small rapidly changing strains during primary creep as well as the very large strains in tertiary creep. The data is automatically reduced to equations relating stress, strain, temperature, and time which can be input directly to nonlinear finite element stress analysis programs. An example of the acquisition, reduction, and application of the data is illustrated. (auth)

48406 MATERIALS CREEP BEHAVIOR AND ELEVATED TEMPERATURE DESIGN. Blackburn, L. D.; Tobin, J. C.; Moen, R. A. (Hanford Engineering Development Lab., Richland, Wash.). Nucl. Technol.; 16: No. 1, 278-86(Oct 1972).

New elevated temperature design criteria are based on time-dependent material deformation behavior. These criteria establish time-dependent allowable stresses which are evaluated from a consideration of three quantities: the stress to produce rupture; the stress to produce the onset of tertiary creep; and the stress to produce one percent total strain. These quantities must be determined over a time range from 10 to 200,000 hours for temperatures from 800 to 1300°F. Allowable stress values for Types 304 and 316 stainless steels were derived from an analysis of experimental creep data. Stress quantities associated with rupture and tertiary creep were largely determined from existing data and analysis methods, while new data and analysis procedures were employed to evaluate the stress to produce one percent strain. An analytical formulation describing the transient and steady-state creep strain response observed in constant-load, constant-temperature tests was developed for use in structural analysis. This formulation was used with an equation-of-state approach based on strain hardening for application to variable load or temperature conditions. (auth)

48407 PROPERTIES OF WELDED JOINTS OF WIRES MADE OF THE ALLOYS Nb + Zr + Ti AND Nb + Ti. Krainskii, I. S.; Shchegolev, I. F. (Inst. of Chemical Physics, Moscow). Instrum. Exp. Tech. (USSR) (Engl. Transl.); 14: No. 5, 1551-3(1971).

Translated from Prib. Tekh. Eksp.; 14: No. 5, 242-4(1971).

It was shown that by choosing the contact-welding operating mode and subsequent processing using pressure, that the critical current of welded joints may be increased to a level close to the critical current of welded 65BT, NT-50, T-60 wires. The critical current of the welded joints is a maximum when the magnetic field is applied perpendicular to the direction of the pressure. (auth)

48408 BERYLLIUM SOLUBILITY IN Ti, V, Nb, AND Ta CUBIC CARBIDES. Zainulin, Yu. G.; Alyamovskii, S. I.; Shveikin, G. P.; Shchetnikov, E. N.; Gel'd, P. V. (Inst. of Chemistry, Sverdlovsk, USSR). Tr. Inst. Khim., Akad. Nauk SSSR, Ural. Filial; No. 20, 68-70(Sep 1970). (In Russian).

The reaction of Be with the carbides of Ti, Nb, Ta, and V (compositions: $TiC_{0.65}$, $TiC_{0.91}$, $NbC_{0.77}$, $TaC_{0.76}$, and $VC_{0.80}$) of a rock salt cubic structure were investigated in a vacuum (5×10^{-6} mm Hg) in the temperature range 1,100 to 1,500°C. With the exception of Ti carbide, the carbides formed a cubic solid solution the lattice period of which increased with increasing Be content. A displacement-intrusion mechanism is proposed. (tr-auth)

48409 NEW METAL ALLOYS WITH HIGH MELTING POINTS. Sadaj, Jerzy; Szymanski, Tadeusz. Rudy Metale Niezelaz.; 17: No. 4, 144-8(Apr 1972). (In Polish).

Methods for improving the mechanical properties of alloys are discussed. One suggestion for obtaining alloys of high properties is to produce them from high-melting metals. High-melting alloys of improved physical and mechanical properties, such as Ti-base, Nb-base, Co-base, W-base, Mo-base, and Ta-base alloys are discussed. (P.C.H.)

48410 EARLY TRANSITION METALS. Kepert, D. L. London; Academic Press (1972). 509p. Pounds 8.

The subject is considered in chapters entitled; general properties of the early transition metals (introduction, high coordination numbers, metal-to-metal bonding, isopoly and heteropolyanions), group IV-titanium, zirconium, hafnium (oxidation state IV, oxidation state III, oxidation states ≤II), group V-vanadium, niobium, tantalum (oxidation state V, oxidation state IV, oxidation state III, oxidation states ≤II), and group VI-chromium, molybdenum, tungsten (oxidation state VI, oxidation state V, oxidation state IV, oxidation state III, oxidation states II and I, oxidation state ≤0). (UK)

48411 PHASE DIAGRAM OF THE SYSTEM NEODYMIUM–ERBIUM. Kobzenko, G. F.; Martinchuk, E. L.; Moiseeva, I. V. (Inst. of Metal Physics, Kiev). Dopov. Akad. Nauk Ukr. RSR, Ser. A; No. 4, 374-6(Apr 1972). (In Ukrainian).

Cast and annealed alloys were studied by the methods of differential thermal, x-ray crystal, and metallographical analyses. Hardness and microhardness of the alloys were measured. Three phase components, two solid solutions on the neodymium and erbium base and one, on the base of chemical compounds, were found. The alloys underwent three non-variant transformations as a function of temperature: $L + \alpha_{Er} \rightleftharpoons \beta_{Nd}$; $\beta_{Nd} + \alpha_{Er} \rightleftharpoons \alpha_{Nd}$; and $\alpha_{Nd} + \alpha_{Er} \rightleftharpoons Nd_xEr_y$. (auth)

48412 PHASE DIAGRAM OF THE SYSTEM CHROMIUM–HOLMIUM. Svechnikov, V. M.; Kobzenko, G. F.; Ivanchenko, V. G. (Inst of Metal Physics, Kiev). Dopov. Akad. Nauk Ukr. RSR, Ser. A; No. 4, 376-8(Apr 1972). (In Ukrainian).

Cast and annealed alloys were studied by the methods of differential thermal, x-ray crystal, metallographical analyses and hardness was measured in a full concentrational range. The phase diagram was plotted corresponding to three non-variant equilibria monotectic (1740), eutectic (1190), and eutectetoid (1090°C) phases. Monotectic fluids contained approximately 2 and 45 at. % Ho. Limit solubility of Ho in chromium (1740°C) was about 1.2% at. (auth)

48413 PHYSICAL METALLURGY OF REFRACTORY METALS AND ALLOYS. Savitskii, E. M.; Burkhanov, G. S. New York; Plenum Publishing Corporation (1970). 299p. $37.50.

Translation of Metallovedenie Tugoplavkikh Metallov i Splavov.

Chapters are included on: natural resources and methods of producing refractory metals; interatomic bond, crystal structure, and principal physical properties of refractory metals; physicochemical interaction of refractory metals with elements of the periodic system; single crystals of refractory metals and alloys; alloys of refractory metals; and melting and treatment of refractory metals and alloys. The present position of the problem of the scientific and industrial utilization of refractory metals, rare metals, and their alloys is also briefly reviewed. A total of 1121 references are cited. (P.C.H.)

48414 MASS SPECTROMETRIC DETERMINATION OF THE BOND DISSOCIATION ENERGIES OF THE MOLECULES CePd AND CeC_2. Cocke, D. L.; Gingerich, K. A. (Texas A and M Univ., College Station). J. Phys. Chem.; 76: No. 16, 2332-6(3 Aug 1972).

The mass spectrometric Knudsen effusion technique was used to investigate the vapor phase over the Ce–Pd–C system. The new molecule, CePd, was identified and third-law enthalpies, ΔH_0^0, of the reactions (1) $CePd(g) = Ce(g) + Pd(g)$, (2) $CePd(g) + C_2(g) = CeC_2(g) + Pd(g)$, and (3) $Ce(g) + 2C(graph) = CeC_2(g)$, were evaluated as +76.8 ± 0.8, –78.0 ± 0.1 and +39.9 ± 1.9 kcal, respectively. The second-law value of ΔH_0^0 for reaction 1 is 74.0 ± 2.9 kcal and for reaction 3 is 41.9 ± 7.4 kcal. The dissociation energy, D_0^0, of the molecule CePd was obtained as 76.1 ± 4 kcal mol^{-1} and its heat of formation, ΔH_{f298}^0, derived as 114 ± 5 kcal mol^{-1}. The dissociation energy of the CePd molecule is discussed in terms of the Pauling model of a polar bond and the Brewer–Engel theory. (auth)

48415 DISPERSION STRENGTHENING OF REFRACTORY METALS. A SURVEY. Samsonov, G. V.; Alfintseva, R. A. (Inst. of Materials Science, Kiev). Sov. Powder Met. Metal Ceram. (Engl. Transl.); 11: No. 2, 98-108(Feb 1972).

Translated from Porosh. Met., Akad. Nauk Ukr. SSR; 11: No. 2, 19-32(Feb 1972).

The dispersion strengthening of Cr, W, Mo, and Nb is reviewed. For niobium, molybdenum, and tungsten, the oxides ZrO_2, ThO_2, and HfO_2 may be regarded as the best strengthening additions. The solubility of carbides of the transition metals of groups IV, V, and VI A in niobium, chromium, and molybdenum attains several atomic per cent or even more. The fact that the solubility of carbides of the transition metals sharply falls with decreasing temperature has enabled a number of dispersion-strengthened aging alloys (based on chromium, molybdenum, and niobium) to be formulated, which, however, should be used only at temperatures at which no carbide dissolution takes place. Nitrides as dispersed strengthening phases have been investigated less fully than oxides and carbides. The nitrides ZrN and HfN may be regarded as potentially useful. Borides are very unstable compared with oxides, carbides, and nitrides, and cannot be used as dispersed phases for the strengthening of refractory metals. A fundamental thermodynamic rule has been established for the selection of a dispersed phase: The compound used must have a high free energy of formation. Compounds such as ZrO_2, ThO_2, and HfO_2 have high values of energy of formation and are stable in refractory metallic matrices up to high temperatures. Grain growth, as a diffusion process, is governed by the nature of the dispersed phase: the more stable the second phase at a given temperature, the finer is the grain. It has been established that the basic conditions for slow grain growth are low solubility in the matrix of the element forming the refractory compound, a low diffusion coefficient of this element, and also low surface energy at the matrix/refractory compound interface. The driving force for particle growth is the tendency of the system to decrease its interfacial energy. A study of the stability of dispersed oxides in metallic matrices demonstrated that the energy of activation for particle growth is equal to the energy of activation for the diffusion of the oxide-forming element in a solid solution of the metallic matrix (in the case of diffusion-controlled particle growth). When such magnitudes as the energy of activation for diffusion and the solubility of the element forming the refractory compound cannot be changed, it may be desirable to alloy the matrix in order to reduce surface energy at the interface. Decrease in interfacial energy radically improves the wetting of a refractory compound by a metallic matrix. As examples may be quoted Cr–MgO and Cr–Al_2O_3 composites, which are among the best material, because they combine high strength properties with good ductility. This combination is apparently a consequence of the fact that, in these materials, the problem of coexistence of a dispersed phase and a matrix has been successfully solved: a spinel-type oxide, $CrO_3 \cdot MgO$, forms at the Cr–MgO interface, while a solid solution of Al_2O_3 in Cr_2O_3 forms at the Cr–Al_2O_3 interface. The formation of such intermediate layers decreases interfacial energy and improves wetting, resulting in a strong bond between the oxides and their matrices and, consequently in high strength properties. (60 references). (auth)

48416 POLYTHERMAL Ti–ΣMoNi (9:1) SECTION OF THE TERNARY SYSTEM Ti–Mo–Ni. Kalabukhova, S. V.; Mikheev, V. S. (Inst. of Metallurgy, Moscow). Sov. Powder Met. Metal Ceram. (Engl. Transl.); 11: No. 2, 109-12(Feb 1972).

Translated from Porosh. Met., Akad. Nauk Ukr. SSR; 11: No. 2, 33-7(Feb 1972).

As a result of an investigation of the titanium corner of the system Ti–Mo–Ni, a partial phase diagram of the Ti + (0–55%) ΣMoNi (9:1) section was constructed. The solubility of Mo and Ni in α-Ti is 0.65% ΣMoNi. The $\alpha + \beta$ phase field is bounded by ΣMoNi contents of 0.65 and ~17% at 600°C, 0.5 and 14% at 700°C, and ~0.4 and ~6% at 800°C. At ΣMoNi contents of 55% and higher, there is a $\beta + Ti_2Ni$ field, the existence of which was confirmed by x-ray structural studies. (auth)

48417 ORDERED ALLOYS. STRUCTURAL APPLICATIONS AND PHYSICAL METALLURGY. Proceedings of the Third Bolton Landing Conference, Lake George, New York, September 8–10, 1969. Kear, Bernard H.; Sims, Chester T.; Stoloff, Norman S.; Westbrook, Jack H. (eds.). Baton Rouge, La.; Claitor's Publishing Division (1970). 588p. $20.00. (CONF-690966).

Thirty-seven articles are included; separate abstracts were prepared for 16. One article on size distributions of antiphase domains in Cu_3Au was previously abstracted in NSA as 25: 3941. The remaining 20 articles contain information on: intermetallic compounds in structural applications; theory of order and phase stability; stacking and stacking faults; mechanism and kinetics of ordering; mechanical behavior of single phase intermetallics; and microstructure and mechanical properties of multiphase alloys. (P.C.H.)

For abstracts of individual papers see: 48418–48433.

48418 THERMODYNAMIC PROPERTIES IN ORDERED INTERMETALLIC COMPOUNDS WITH CsCl STRUCTURE. Ettenberg, M.; Komarek, K. L.; Miller, E. (New York Univ., N. Y.). pp 49-65 of Ordered Alloys. Structural Applications and Physical Metallurgy. /Kear, Bernard H. (ed.). Baton Rouge, La.; Claitor's Publishing Div. (1970).

From third Bolton Landing conference on ordered alloys; Bolton Landing, NY. (8 Sep 1969). See CONF-690966.

Most intermetallic AB compounds crystallize in the CsCl structure. They can be divided into compounds with very limited solid solubility and in compounds with extended solid solubility. A very important sub-group of the latter are CsCl-compounds formed in transition metal–aluminum systems. Thermodynamic activities of solid V–Al alloys have been determined by an isopiestic method and compared with previously obtained data on the Cr–Al, Fe–Al, Co–Al, Ni–Al, and Pd–Al systems. The defect structure in these compounds is proposed to be of a coupled antistructure-vacancy type. New mass action equations are proposed for these defect equilibria and theoretical equations were derived relating thermodynamic activities to the intrinsic disorder. A linear relationship between the coefficients of intrinsic disorder and the heats of formation of these compounds was found. (40 references). (auth)

48419 ELECTRON STRUCTURE AND THE ORDERING PROCESSES IN NICKEL BASE TERNARY ALLOYS OF THE TRANSITION ELEMENTS. Panin, V. E.; Fadin, V. P.; Prushchinskii, V. V.; (and others) (Tomsk State Univ., USSR). pp 81-94 of Ordered Alloys. Structural Applications and Physical Metallurgy. /Kear, Bernard H. (ed.). Baton Rouge, La.; Claitor's Publishing Div. (1970).

From third Bolton Landing conference on ordered alloys; Bolton Landing, NY. (8 Sep 1969). See CONF-690966.

A general statistical theory of ordering of ternary alloys having bcc and fcc lattices is considered. The concentration dependence of the temperature of the phase transition "order-disorder" was derived from the condition of equality of the chemical potentials of the components of a ternary alloy having the fcc lattice in both the ordered and disordered phases. The adsorption of atoms of the ternary alloy on the antiphase boundaries (APB) of the order domains and its influence on ordering were investigated theoretically. It was found that the alloying of a binary alloy by a certain third element can stabilize the fine domain structure in the ordered alloy by virtue of its adsorption on the APB. The processes of ordering in the ternary alloys of the quasi-binary section Ni_3Mn–Ni_3Me (Me = Co, Fe, Cr, Mo, W, Cu, Al, etc.) were investigated experimentally. The values of the parameters of the long-range order were measured by neutron diffraction for a number of these ternary alloys after various heat treatments. The effects of ordering on the resistivity, the absolute thermopower, the Hall constants, the internal saturation induction, the Nernst-Ettinghausen constant, a number of mechanical characteristics, and their temperature dependencies were measured. The influence of a third element on the effects of ordering in the alloys studied was found to be mainly determined by the change of their electron structure upon alloying. Kinetic studies of ordering in the ternary alloys mentioned established that the influence of a third element can be different at different stages of ordering. The character of the influence was determined by the nature of the alloying element, deceleration of the ordering processes taking place in the alloys in which strong adsorption of a third element on the APB can be expected. The changes of the electron structure of Ni_3Mn by alloying and by ordering were investigated. The results were analyzed on the basis of the zone model of the electron structure of the alloys of the transition elements. The same kind of analysis was carried out for a great number of ternary alloys based on Ni_3Fe as well (according to data in literature). These considerations permit an explanation of the main experimental regularities of the influence of a third element on the processes of ordering in terms of the nature of the alloying element and its concentration. (44 references.) (auth)

48420 EFFECTS OF COMPOSITIONAL VARIATIONS ON THE ATOMIC ORDERING IN A15 PHASES. Waterstrat, R. M. (National Bureau of Standards, Washington, D. C.); van Reuth, E. C. pp 95-110 of Ordered Alloys. Structural Applications and Physical Metallurgy. /Kear, Bernard H. (ed.). Baton Rouge, La.; Claitor's Publishing Div. (1970).

From third Bolton Landing conference on ordered alloys; Bolton Landing, NY. (8 Sep 1969). See CONF-690966.

Binary A15 phases containing only transition elements have been found to possess composition ranges which shift in a regular manner consistent with periodic table positions. This is suggestive of the so-called "electron-compound" behavior previously noted for the sigma phases and other complex structures. It was found that deviations from the "ideal" (A_3B) composition are accomplished by direct substitution of A-elements and B-elements rather than by vacancy formation. The degree of long-range atomic ordering decreased as elements closer to the manganese column in the periodic table were selected. This effect may be related to the extent of overlapping for d-electron wave-functions particularly along the chains of A-site atoms and is consistent with the band structure model proposed by Labbé and Friedel (J. Phys. Radium 27, 153, 303(1966)). (auth)

48421 RELATIVE STABILITY OF VARIOUS STACKING ORDERS IN CLOSE-PACKED METAL STRUCTURES. Havinga, E. E.; van Vucht, J. H. N.; Buschow, K. H. J. (Philips Research Labs., Eindhoven, Netherlands). pp 111-24 of Ordered Alloys. Structural Applications and Physical Metallurgy. /Kear, Bernard H. (ed.). Baton Rouge, La.; Claitor's Publishing Div. (1970).

From third Bolton Landing conference on ordered alloys; Bolton Landing, NY. (8 Sep 1969). See CONF-690966.

Theoretical considerations, mainly involving long-range interactions, are presented in order to explain the occurrence of the observed types of close-packed structures in metallic elements, intermetallic compounds, and alloys. The theory is based on the long-ranged oscillating forces due to the screening of the atomic potentials by the valence electrons. These forces can be summed in the way indicated by Blandin et al. to an effective interaction between close-packed planes. The method is essentially a simple semi-quantitative approximation of Brillouin-zone effects. As it is based on a nearly-free electron model, it is only applied to non-transition metals and alloys. The refinement applied includes: a screening, due not only to the finite paths of the Fermi electrons, but also to the finite values of the pseudo potentials; relativistic effects, which for many metals are equally important as the non-relativistic scattering of the Fermi electrons; and a volume effect in ordered AB_3 compounds, depending on the radius ratio of the atoms A and B. The results were compared with the experimental facts for the metallic elements, the intra-rare-earth alloys, the rare earth–thorium alloys and for intermetallic compounds AB_3. The theory was less successful for the alloys of the noble metals with multivalent elements. In the system $BaPb_3$–$BaTl_3$ a new structure type, predicted by the theory, was actually found and is described. (auth)

48422 ORDERING OF Ni_2V: INITIAL OBSERVATIONS. Tanner, Lee E. (Kennecott Copper Corp., Lexington, Mass.). pp 253-8 of Ordered Alloys. Structural Applications and

Physical Metallurgy. /Kear, Bernard H. (ed.). Baton Rouge, La.; Claitor's Publishing Div. (1970).

From third Bolton Landing conference on ordered alloys; Bolton Landing, NY. (8 Sep 1969). See CONF-690966.

A brief summary is presented of microstructural observations of the transition to long-range order in stoichiometric Ni_2V. The transformation proceeds by nucleation and growth exhibiting a marked variation in mode and morphology with decreasing reaction temperature. (auth)

48423 MECHANICAL PROPERTIES AND DOMAIN STRUCTURE OF ORDERED Ni_4Mo. Snyder, W. B.; Brooks, C. R. (Univ. of Tennessee, Knoxville). pp 275-96 of Ordered Alloys. Structural Applications and Physical Metallurgy. /Kear, Bernard H. (ed.). Baton Rouge, La.; Claitor's Publishing Div. (1970).

From third Bolton Landing conference on ordered alloys; Bolton Landing, NY. (8 Sep 1969). See CONF-690966.

Above 868°C, a nickel-20 atom percent molybdenum alloy (Ni_4Mo) had a face-centered cubic, disordered structure, but formed a long-range ordered structure below this temperature. However, the disordered structure could be retained by rapid cooling from above 868°C. Tensile curves and hardness data at 25°C have been obtained for this alloy as a function of time (up to 97 hours) at 775°C after quenching from 1000°C (that is, as the disordered Ni_4Mo orders). Within five minutes, the alloy became stronger, the yield strength approximately doubling; the elongation at fracture was about one percent, whereas the as-quenched condition was very ductile. Further time at 775°C decreased the yield strength, eventually below the as-quenched value, but the alloy remained very brittle. Optical microscopy and electron fractography revealed that the ordered alloy fractured along the planes that were the grain boundaries of the disordered phase. Correlations between the mechanical properties and the domain size and orientations (determined by thin-film, transmission electron microscopy) are discussed. (auth)

48424 MECHANISM OF ORDERING IN Ni_4Mo: INITIAL OBSERVATIONS. Okamoto, P.; Thomas, G. (Univ. of California, Berkeley). pp 297-99 of Ordered Alloys. Structural Applications and Physical Metallurgy. /Kear, Bernard H. (ed.). Baton Rouge, La.; Claitor's Publishing Div. (1970).

From third Bolton Landing conference on ordered alloys; Bolton Landing, NY. (8 Sep 1969). See CONF-690966.

The results of a parallel transmission electron and field-ion microscopy study of the very early stages of ordering in Ni_4Mo suggest that the transition from the disordered to the ordered state at low temperatures occurs by a homogeneous process. A diffraction model based on periodic composition modulations normal to the $\{420\}$ planes of the disordered phase appeared to be compatible with the main features of observed diffraction patterns including the $1\frac{1}{2}0$ positions of the short-range order peaks. (auth)

48425 PRISMATIC SLIP IN Mg_3Cd. Noble, F. W.; Kirby, J. H. (Univ. of Liverpool). pp 321-30 of Ordered Alloys. Structural Applications and Physical Metallurgy. /Kear, Bernard H. (ed.). Baton Rouge, La.; Claitor's Publishing Div. (1970).

From third Bolton Landing conference on ordered alloys; Bolton Landing, NY. (8 Sep 1969). See CONF-690966.

The deformation behavior of single crystals of Mg_3Cd deforming by prismatic slip has been determined as a function of testing temperature and state of order. Below 300°K ordering was found to reduce both the temperature dependent and the temperature independent components of the critical resolved shear stress. Possible causes of this effect are discussed. Above 300°K the variation of degree of order with testing temperature led to the formation of two peaks in the C.R.S.S. vs temperature curve for prismatic slip. This behavior was compared with the behavior of basal slip and the flow stress of polycrystalline Mg_3Cd in the same temperature range. (auth)

48426 STRUCTURE AND PROPERTIES OF ALLOYS CONTAINING VERY SMALL ORDERED PARTICLES. Gaudig, W. (Max-Planck-Institut fuer Metallforschung, Stuttgart); Okamoto, P.; Schanz, G.; Thomas, G.; Warlimont, H. pp 347-63 of Ordered Alloys. Structural Applications and Physical Metallurgy. /Kear, Bernard H. (ed.). Baton Rouge, La.; Claitor's Publishing Div. (1970).

From third Bolton Landing conference on ordered alloys; Bolton Landing, NY. (8 Sep 1969). See CONF-690966.

In the short range ordered Cu-Al, Cu-Zn, Fe-Al and Ni-Mo alloys electron and field ion microscopy and diffraction effects indicate the presence of discrete ordered regions in a less ordered or disordered matrix. It is possible to reinterpret and correlate previous observations with these findings. Since diffraction studies of several other alloy systems yield corresponding results it is suggested that a coherent two-phase mixture in which the ordered phase is limited to a small equilibrium particle size is frequent if not common in short range ordered alloys. The yield stress and work hardening behavior of short range ordered Fe-Al alloys have been investigated and were interpreted in terms of their structural features. (auth)

48427 PRECIPITATION OF ORDERED PHASES IN TERNARY AND QUARTERNARY FERRITIC ALLOYS. Bower, E. N.; Whiteman, J. A. (Univ. of Sheffield, Eng.). pp 405-24 of Ordered Alloys. Structural Applications and Physical Metallurgy. /Kear, Bernard H. (ed.). Baton Rouge, La.; Claitor's Publishing Div. (1970).

From third Bolton Landing conference on ordered alloys; Bolton Landing, NY. (8 Sep 1969). See CONF-690966.

The precipitation of ordered intermetallic phases in ternary ferritic alloys is reviewed in detail. Information about the morphology, structure, distribution, and coarsening kinetics of the ordered precipitates is presented. The mechanical properties and deformation mechanism of a ferritic Fe-Si-Ti alloy of this type is described in detail. The aging of martensitic alloys developed from the ternary alloys was examined and methods of improving the mechanical properties of such alloys are described. (auth)

48428 STRUCTURE, MECHANICAL PROPERTIES, AND DEFORMATION BEHAVIOR OF Ti-Al AND Ti-Al-X ALLOYS. Williams, J. C. (North American Rockwell Corp., Thousand Oaks, Calif.); Blackburn, M. J. pp 425-45 of Ordered Alloys. Structural Applications and Physical Metallurgy. /Kear, Bernard H. (ed.). Baton Rouge, La.; Claitor's Publishing Div. (1970).

From third Bolton Landing conference on ordered alloys; Bolton Landing, NY. (8 Sep 1969). See CONF-690966.

Strengthening due to the precipitation of the ordered α_2 phase (based on Ti_3X) has been studied in binary and ternary $Ti-Al-X^3$ (where X = Sn, Ga, In, or Pb) alloys. The observed strengthening can be separated into two principal components; one due to the dislocation/ordered particle interaction and the other due to dislocation/precipitate stress field interactions. The former of these appears more important in some cases, e.g., Ti-Al-Sn alloys; whereas the latter appears to predominate in other cases, e.g., Ti-Al-Ga alloys. It was found that the brittleness of single phase Ti_3Al is related to slip morphology and the decreased extent of $\langle 11\bar{2}3\rangle$ glide with increasing Al content. The marked improvement in strength and ductility of the $Ti_3(Al_{0.5}Ga_{0.5})$ and $Ti_3(Al_{0.25}Ga_{0.75})$ compounds resulted from the phase separation into $\alpha_2 + Ti_2Ga$ with an accompanying change in slip morphology and an increase in the extent of $\langle 11\bar{2}3\rangle$ glide. (auth)

48429 METALLURGICAL DESIGN OF A SUPERALLOY. Davies, R. G.; Johnston, T. L. (Ford Motor Co., Dearborn, Mich.). pp 447-74 of Ordered Alloys. Structural Applications and Physical Metallurgy. /Kear, Bernard H. (ed.). Baton Rouge, La.; Claitor's Publishing Div. (1970).

From third Bolton Landing conference on ordered alloys; Bolton Landing, NY. (8 Sep 1969). See CONF-690966.

Structural features of nickel-base superalloys are discussed that are believed to control their mechanical properties. Both flow stress and creep strength are considered in terms of the influence of the dispersion and volume fraction of γ', and of those elements that are present in solid solution in both the γ and γ' phases. Creep performance is intimately connected with maintaining the maximum amount of γ/γ' interfacial area. For maximum stability of the γ' precipitate dispersion at high temperatures under stress, there must be zero mismatch between the lattices of the γ matrix and the γ' particle. From a knowledge of alloy partitioning between the γ and γ' phases the roles that different elements play can be identified and used as a rational basis for the selection of superalloy compositions. (42 references). (auth)

48430 CREEP IN ORDERED ALLOYS. Strutt, P. R. (Univ. of Connecticut, Storrs); Dodd, R. A. pp 475-504 of Ordered Alloys. Structural Applications and Physical Metallurgy. /Kear, Bernard H. (ed.). Baton Rouge, La.; Claitor's Publishing Div. (1970).

From third Bolton Landing conference on ordered alloys; Bolton Landing, NY. (8 Sep 1969). See CONF-690966.

The high temperature creep behavior of nickel-base alloys with the LI_2 and B_2 type lattices was reviewed in detail, but for comparative purposes reference is made to other alloy systems, notably those with the B_2 type lattice. A point that is strongly emphasized (since it is believed to be essential to a full understanding of creep) is the correlation of mechanical measurements with quantitative electron microscope observations of dislocation configurations formed during creep. The application of dislocation dynamics to creep phenomenon by others is discussed. By this approach it is possible to predict the criteria for the existence of an incubation period and the nature of the creep curve. Several general theories of steady-state creep and their application to creep in ordered alloys are also discussed. In considering slip in the LI_2 and B_2

lattices reference is made to the hard sphere model and the atomic displacements associated with various possible dislocation dissociations are discussed. Details are given of recently published work dealing with a unique dislocation dissociation in the LI_2 lattice, and its application to an explicit mechanism for viscous creep in a nickel-base superalloy. In considering creep in single crystals of β-NiAl the normalized creep rate vs normalized stress curve was found to be orientation dependent. Furthermore the nature of the dislocation structure depends upon the magnitude of the applied stress. A summary is given in which possible experiments that would further increase the understanding of creep in ordered alloys are considered. (78 references). (auth)

48431 FATIGUE OF NICKEL-BASE SUPERALLOYS. Gell, M.; Leverant, G. R. (Pratt and Whitney Aircraft, Middletown, Conn.). pp 505-23 of Ordered Alloys. Structural Applications and Physical Metallurgy. /Kear, Bernard H. (ed.). Baton Rouge, La.; Claitor's Publishing Div. (1970).

From third Bolton Landing conference on ordered alloys; Bolton Landing, NY. (8 Sep 1969). See CONF-690966.

The fatigue behavior of nickel-base superalloys is reviewed with particular emphasis on the role played by the ordered γ' precipitate in these two phase $(\gamma + \gamma')$ materials. A comparison was made between the fatigue properties of superalloys and those of both single phase γ and single phase γ'. A correlation between deformation character and the mode of fatigue crack propagation was found for the superalloys. Finally, the importance of microstructural defects such as micropores, brittle second phase particles, and grain boundaries on fatigue crack initiation is discussed. (30 references). (auth)

48432 FRACTURE OF CsCl TYPE SUPERLATTICES. Stoloff, N. S. (Rensselaer Polytechnic Inst., Troy, N. Y.). pp 525-44 of Ordered Alloys. Structural Applications and Physical Metallurgy. /Kear, Bernard H. (ed.). Baton Rouge, La.; Claitor's Publishing Div. (1970).

From third Bolton Landing conference on ordered alloys; Bolton Landing, NY. (8 Sep 1969). See CONF-690966.

Three primary causes of brittleness in ordered compounds of CsCl structure are insufficient deformation modes, restricted cross slip, and impurity segregation to grain boundaries. Metallurgical factors bearing on these problems are discussed. Means of alleviating brittleness include alloying, thermal treatment, and introduction of a stable substructure by extrusion or by annealing a cold worked material below its recrystallization temperature. (36 references). (auth)

48433 USE OF NICKEL–ALUMINUM INTERMETALLIC SYSTEMS AS COATINGS FOR HIGH TEMPERATURE NICKEL BASE ALLOYS. Boone, D. H.; Goward, G. W. (Pratt and Whitney Aircraft, Middletown, Conn.). pp 545-64 of Ordered Alloys. Structural Applications and Physical Metallurgy. /Kear, Bernard H. (ed.). Baton Rouge, La.; Claitor's Publishing Div. (1970).

From third Bolton Landing conference on ordered alloys; Bolton Landing, NY. (8 Sep 1969). See CONF-690966.

The early promise of oxidation resistant intermetallic compounds, such as NiAl, for applications as structural materials at elevated temperatures has not been fulfilled because of deficiencies in mechanical properties such as low temperature ductility and high temperature strength. Certain intermetallic compounds are, however, widely used as protective coatings on high temperature alloys. Probably the largest engineering use of NiAl is as protective coatings on nickel-base alloys. Because of the unique diffusional processes occurring in Ni_2Al_3 (aluminum diffusion) and NiAl (nickel diffusion) during the formation of nickel aluminide coatings, only two structural types of coatings are possible. Stabilizing heat treatment results in the formation of a pseudo-equilibrium structure based on NiAl, which is the common intermetallic of all such coatings in practical use. Coating degradation involves removal of aluminum through repeated formation and spalling of protective oxides, insignificant amounts of aluminum being lost by diffusion into the substrate alloys. The mechanical properties of NiAl coatings exert important effects on the mechanical behavior of coating-alloy systems. In particular, an apparent ductile-brittle transition temperature, related to the aluminum content of the NiAl, was observed. The limitations of the understanding of other mechanical effects are related to an incomplete understanding of these effects in bulk NiAl. Although even less basic information is available on the intermetallics involved in coatings on cobalt and refractory metals such as niobium and molybdenum, oxidation and mechanical effects, similar to those for NiAl, can be inferred for these systems. Critical questions are raised as guides to future research in this interesting class of intermetallics, which already has widespread engineering utility as protective coatings. (auth)

48434 PLASTIC DEFORMATION AND BRITTLENESS OF Fe–Co–V. Dinhut, J. F.; Eymery, J. P.; Moine, P. (Faculte des Sciences, Poitiers, France). Phys. Status Solidi (a); 12: No. 1, 153-61(16 Jul 1972).

The alloy 49% Fe–49% Co–2% V is bcc below about 900°C and orders into a B_2 superlattice below a critical temperature near 730°C. The deformation of this compound was studied by tensile tests performed at strain rates within the range 0.01 to 670% sec^{-1} and at temperatures between 20 and 750°C. The dislocation configuration and the antiphase domain shape after slight strains were observed. It was found that brittleness depends on the strain rate; for values higher than 3.4% sec^{-1}, there is only one brittle–ductile transition; for values lower than 3.4% sec^{-1}, two transitions can be noticed. The second decrease in ductility happens when the yield stress reaches its maximum. Each transition was connected with a change in the deformation mode. (auth)

48435 OPERATIVE SLIP SYSTEMS IN β-PHASE Ag–Cd AND Ag–Zn ALLOYS. Krishnan, R. V.; Brown, L. C. (Univ. of British Columbia, Vancouver). Phys. Status Solidi (a); 12: No. 1, K35-7(16 Jul 1972).

Single crystals of Ag–45 at.% Cd and Ag–41 at.% Zn were tested in tension. The slip plane and direction were determined to be $\{112\}$ and $\langle 11\bar{1} \rangle$ for Ag–Cd and $\{110\}$ and $\langle \bar{1}11 \rangle$ for Ag–Zn. Coarse slip was observed in Ag–Cd with tensile axis close to the [001] pole. (D.L.C.)

48436 PARTIAL STRUCTURE FACTORS AND ATOMIC DISTRIBUTIONS IN LIQUID Hg–In AND Hg–Tl ALLOYS. Waseda, Y.; Kuroha, M.; Suzuki, K.; Ohtani, M. (Tohoku Univ., Sendai). Phys. Status Solidi (b); 52: No. 2, 571-9(1 Aug 1972).

Three partial structure factors, $S_{ij}(Q)$, were evaluated from the scattered x-ray intensities of liquid Hg–Tl alloys measured by Halder et al. and of liquid Hg–In alloys measured by Halder and Wagner assuming that the $S_{ij}(Q)$ are independent on the relative abundance of the respective elements in the alloys. The functions $S_{ii}(Q)$ and $S_{jj}(Q)$ and their reduced radial distribution functions $G_{ii}(r)$ and $G_{jj}(r)$ obtained are very similar to those observed in their respective pure liquid metals. In both cases the partial $S_{ij}(Q)$ and $G_{ij}(r)$ have maxima which lie in between those of the pure elements. From these results, liquid Hg–In and Hg–Tl alloys seem to be interpreted as random mixing fluids. Besides, the electrical resistivity was calculated using Faber–Ziman's theory and the pseudopotential of Evans and compared with experimental data. (auth)

48437 TUNGSTEN–RHENIUM ALLOYS. EFFECT OF THE DIFFERENT METHODS OF PREPARATION ON THE PROPERTIES OF THESE ALLOYS. Pastor, H. (Ugine Carbone, Grenoble, France). Rev. Int. Hautes Temp. Refract.; 9: No. 1, 43-76(Jan 1972). (In French).

From Meeting of the French Society of High Temperatures; Clermont-Ferrand, France (22 Oct 1970). See CONF-701028.

The refractory metals are categorized among the refractory compounds, a table of their physical, mechanical, and chemical properties being given. The following aspects of tungsten–rhenium alloys are discussed: phase diagrams, preparation, working and welding, physical metallurgy, mechanical properties, physics and chemistry, and utilization. A description is given of the various methods of preparing these alloys. The advantages of using powder metallurgy techniques are emphasized. The variations in the structural and mechanical properties with the different methods of preparation are compared. The characteristics of the rhenium effect in the recrystallization and the ductile–brittle transition are discussed. (France)

48438 HIGH TEMPERATURE DEFORMATION OF ZIRCONIUM AND ZIRCONIUM–TIN ALLOYS. Luton, Michael John. Montreal; McGill Univ. (1971). National Library of Canada, Ottawa.

Thesis.

Compression tests were carried out on polycrystalline samples of α-zirconium and zirconium–tin alloys. The tests were performed between 625 and 925°C and at strain rates from 10^{-4} to 1 s^{-1}. Both yield and steady state stresses were determined and found to be strongly strain rate and temperature sensitive. At low temperatures and high strain rates the yield stress was nearly independent of strain rate and temperature, indicating a shift to athermal deformation. Activation analysis of the experimental data led to activation areas in the range 1000 to $100b^2$, which decreased rapidly with stress but only slightly with tin content. Results of the analysis indicated that a particular aspect of the intersection process is likely to be rate controlling. The strengthening effect of tin is attributed to an accompanying decrease in stacking fault energy, leading to increases in the work of intersection. The increase in flow stress from yield to the steady state regime was attributed to an increase in substructure density, leading to an increase in internal stress. The activation entropy for high T flow is discussed and a comparison is made between the activation parameters pertaining to empirical stress laws and the conventional rate equation. (Diss. Abstr. Int., B)

48439 MEASUREMENT OF MELTING POINT AND ELECTRICAL RESISTIVITY (ABOVE 3600 K) OF TUNGSTEN BY A PULSE HEATING METHOD. Cezairliyan, Ared (National Bureau of Standards, Washington, D. C.). High Temp. Sci.; 4: No. 3, 248–52(Jun 1972).

A subsecond-duration pulse-heating method is used to measure the melting point and electrical resistivity of tungsten above 3600°K. The results yield a value of 3695°K (on the International Practical Temperature Scale of 1968) for the melting point with an estimated inaccuracy of 15°K. Estimated inaccuracy in electrical resistivity measurements is 1%. (auth)

48440 DOMAIN WALLS IN FERROMAGNETIC Dy. Egami, Takeshi. Philadelphia; Univ. of Pennsylvania (1971). 194p. University Microfilms Order No. 72-17,344.
Thesis.

The conventional idea of the ferromagnetic domain wall, or Bloch wall, is that the wall is microscopically a gradual transition region of the spin configuration whose width extends over hundreds of atoms. However, such a concept does not apply for some materials that have drawn attention recently, such as the rare earth metals and their compounds where the magnetic anisotropy is large, and the exchange interaction sometimes prefers periodic spin structures. Concentrating on Dy, since it has one of the simplest spin structures and is one of the most extensively studied elements in the rare earth series, the microscopic properties of the ferromagnetic domain wall were studied both theoretically and experimentally. First computations were made on the spin configuration and the magnetic energy of the wall in Dy (and Tb) with the aid of a digital computer. It was found that the walls are narrow (only 7 atomic distances), so that the energy of the wall is slightly different depending upon whether the center of the wall is located on an atomic site of the lattice or in between two sites. The wall was found to be stable when its center is between two atomic sites, and when the center is just on an atomic site the wall is metastable and has a higher energy. This energy difference means there is an intrinsic barrier for the motion of the wall just as in the case of the Peierls potential in dislocation theory, and a certain magnetic field has to be applied to initiate the motion of the wall. The required field, or the intrinsic coercive force, was calculated to be 1 kOe for Dy at 0°K, and to decrease with increasing temperature. Based on this prediction the measurement of the coercive force of single-crystal Dy was conducted. It was found that the intrinsic coercive force evidently exists in Dy, and its magnitude and temperature dependence agree well with the prediction. However, it is observable only at high field sweep rates, because the wall can move even below the intrinsic coercive force. The magnetisation rate, which represents the wall velocity, was also measured as a function of magnetic field and temperature, and it was found that the magnetization rate at a fixed field depends strongly on temperature at above 20°K, but stays almost constant below 10°K. Therefore the wall is most probably mobile even at 0°K, implying the mechanism of the wall motion is not a thermal one. Trial was made to interpret the results in terms of the quantum mechanical tunnelling of the wall through the Peierls potential. It was found that the tunnelling mechanism is a plausible one to explain the wall motion; however, a successfully quantitative explanation is yet to be made. The idea of the intrinsic coercive force was conceived also by other authors. However, the quantitative agreement between theory and experiment was obtained only by our study. (Diss. Abstr. Int., B)

48441 SOLUBILITY OF YTTRIUM AND RARE EARTH METALS IN ZINC. D'Yachenko, V. I.; Yurov, V. I.; Kovalevskii, A. V.; (and others) (Ural Polytechnic Inst., Sverdlovsk, USSR). Izv. Vyssh. Ucheb. Zaved., Tsvet. Met.; No. 6, 95–6 (1971). (In Russian).

The solubilities of Y, La, Ce, Nd, Dy, Er, Sm, and Yb were measured in liquid zinc at temperatures of from 500 to 800°C. La, Ce, Nd, and Sm were characterized by somewhat less solubility in Zn than the remaining elements listed. Log x_{Me} vs 1,000/T approximated a linear function over this temperature range, and the values A and B were determined from the solubility data for each element in order to satisfy the relation $\log x_{Me} = A - B/T$. (K.S.W.)

48442 DISTRIBUTION OF IMPURITIES IN THE CRYSTALLIZATION OF METALS BY CHOKHRALSKII METHOD. Chuprikov, G. E.; Pogorelyi, A. D.; Demido, N. M. Izv. Vyssh. Ucheb. Zaved., Tsvet. Met.; No. 6, 97–101(1971). (In Russian).

A common refining method is the crystallization of a material from a melt with the results that a redistribution of impurities occurs at the boundaries of the phase and that some vaporization of the impurities takes place. The distribution of La and Fe as impurities in samples of Y and Gd during recrystallization of the latter was studied. The effectiveness of purification of Y and Gd was related to the conditions of crystallization and to the vapor pressure of components of the mixture. Satisfactory agreement of the experimental data with those calculated for crystals extracted from a melt was noted. (K.S.W.)

48443 Mo–B SYSTEM IN THE HIGH-Mo REGION. Zakharov, A. M.; Novikov, I. I.; Pol'kin, V. S. Izv. Vyssh. Ucheb. Zaved., Tsvet. Met.; No. 6, 126–9(1971). (In Russian).

The solubility of boron in Mo was investigated over the temperature range 1,200 to 2,200°C using microstructure and x-ray methods, and quenching techniques after annealing at various temperatures. The phase diagram was studied up to 4.05% B. The eutectic $\alpha + Mo_2B$ (where α = the solid solution based on Mo) had a B content of from 2.4 to 4.05% weight percent B, and melted at 2,190 ± 20°C. The maximum solubility of B in Mo is ~0.11% at 2,190°C and <0.05 wt% at 1,200°C. The solubility of B in Mo in the solid state between 1,200 and 2,200°C may be described by the equation: $\ln(\text{at.\% B}) = 4.60 - 12.6 \times 10^3/T$, where T is in °K. (K.S.W.)

48444 DEPENDENCE OF VOLUME EFFECT OF CRYSTALLIZATION AND CARBONIZATION OF TRANSITION METALS ON THE TYPE OF VALENCE ELECTRON CONFIGURATION. Samsonov, G. V.; Dudnik, E. M.; Kolotilo, D. M. (Inst. of Problems in Material Studies, Kiev). Dopov. Akad. Nauk Ukr. RSR, Ser. B; No. 2, 161–3(Feb 1972). (In Ukrainian).

Dependence of atom packing effect of the IV–VI group transition refractory metals on configuration change in their valence electrons is considered during crystallization from the melt and carbide formation. Packing effect of transition metal atoms in the process of their crystallization from the melts is shown to rise with an increase in valence electron localization at the atoms cores in d^5-configuration, in carbide formation the inverse dependence takes place. The theoretical interpretation of this phenomenon is presented. (auth)

48445 DIFFUSION IN THE SYSTEM Pd–V INVESTIGATED BY MEANS OF AN ELECTRON MICROPROBE. Lamparter, Peter; Krabichler, Traudl; Steeb, Siegfried (Max-Planck-Institut fuer Metallforschung, Stuttgart). Z. Naturforsch.; 27a: No. 6, 960–5(Jun 1972). (In German).

Diffusion processes (600 to 1300°C) were investigated by means of quantitative electron-probe microanalysis. The composition of the diffusion zone corresponds quite well with the phase diagram. The following phases were observed: solid solutions in Pd, Pd_3V, Pd_2V, and solid solutions in V. Below 900°C the growth of the diffusion zone is retarded; above 900°C the layer grows according to $d = k\sqrt{t}$. For all phases observed, according to Matano's method the coefficients of the interdiffusion were determined. The temperature dependence of these coefficients as well as that of the k values follows an Arrhenius law. Thus the activation energies of the layer growth and of the interdiffusion were obtained. The determination of the intrinsic diffusion coefficients by the observation of the Kirkendall effect is discussed. (auth)

Radiation Effects

Refer also to abstracts 49684, 49799, and 49815.

48446 (GEAP–13737) EVALUATION OF CLADDING ALLOY SWELLING AT HIGH FLUENCES. Appleby, W. K. (General Electric Co., Sunnyvale, Calif. Breeder Reactor Dept.). Feb 1972. Contract AT(04-3)-189. 44p. Dep. NTIS.

Review and analysis of all the available data on the swelling of metals exposed to fast neutrons at high fluence (to ~10^{23} n/cm^2, total) disclose that the mechanisms of void formation and growth are beginning to be understood and that there is real potential for the development of swelling resistant alloys. Recent results ranging from a volume increase of 10% ΔV/V in solution annealed Type-347 stainless steel to densification in Inconel-625 are described in detail. Empirical equations describing swelling as a function of neutron fluence and temperature of irradiation are developed in response to the needs of LMFBR core design. Extrapolation of these correlations predicts maximum volume increases of ~15% ΔV/V for solution annealed Type-321 and cold worked Type-316 compared with ~25% ΔV/V for solution annealed Type-304 at an LMFBR fluence of 2×10^{23} n/cm^2, E > 0.1 MeV. It is concluded from data analysis and theoretical treatments that irradiation-induced metal swelling can be substantially controlled by suitable metallurgical pre-treatment of certain alloys to produce finely dispersed second-phase particles or high dislocation densities. (auth)

48447 (HEDL-TME-72-27) IRRADIATION EFFECTS ON REACTOR STRUCTURAL MATERIALS. Quarterly Progress Report, November 1971–January 1972. Claudson, T. T. (comp.)

(Hanford Engineering Development Lab., Richland, Wash.). Mar 1972. Contract AT(45-1)-2170. 292p. Dep. NTIS.

Research conducted by a number of organizations participating in the AEC structural materials program is reported. Information is included on elevated temperature fatigue, creep, fuel-clad chemical interactions, stress effects, alloy development, radiation effects, tensile properties, mechanical properties, crack growth, strain rate effects, EBR-II irradiations, weldment studies, and studies of advanced reactor materials. (J.R.D.)

48448 (HEDL-TME-72-89) IRRADIATION EFFECTS ON THE FRACTURE OF HEAVY SECTION PRESSURE VESSEL STEELS. Semi-Annual Progress Report, Heavy Section Steel Technology Program, for the Period Ending February 29, 1972. Williams, J. A.; James, L. A. (Hanford Engineering Development Lab., Richland, Wash.). Jun 1972. Contract AT(45-1)-2170. 9p. Dep. NTIS.

Unirradiated tensile yield strengths of A533-B steel from HSST plate 02 were evaluated at strain rates from 10^{-5} to 10^{-1} in the temperature range of -319 to 500°F. The results were correlated with a rate temperature parameter which will serve as a valid basis for more extensive interpretation of studies of the irradiation effect on the strain rate sensitivity of yield strength. The preliminary results of specimens fatigue cycled at room temperature indicate that, at the lower values of ΔK, the fatigue-crack growth rate of A533 steel irradiated to 2.3 to 2.8×10^{19} n/cm^2 is somewhat higher than corresponding behavior of unirradiated material. (auth)

48449 (JAERI-M-4707) RECOVERY OF LATTICE DEFECTS AFTER PLASTIC DEFORMATION AND NEUTRON IRRADIATION AT LOW TEMPERATURE. Takamura, Saburo (Japan Atomic Energy Research Inst., Tokyo). Feb 1972. 115p. NTIS (U. S. Sales Only).

The recovery of electrical resistivity in polycrystalline copper, gold, aluminum, vanadium, and iron, deformed at 4.2°K and in polycrystalline copper, gold, aluminum, iron, molybdenum, and tungsten after fast-neutron irradiation at about 5°K has been studied and the recovery structure was determined from 4.2 to about 400°K. For the recovery stage after deformation, the initial recovery stage (stage I) was attributed to the dislocation rearrangement rather than the annihilation of Frenkel pairs both in fcc metals (Cu, Au, Al) and in bcc metals (V, Fe). The stage II recovery was considered to be due to the migration or dissociation of interstitial clusters in both metals. For the recovery of fcc metals after fast-neutron irradiation at about 5°K, cold-work before irradiation enhanced the recovery above 150°K in Cu and above 50°K in Au. In Au, the stage III recovery shifted by about 30°K toward lower temperature for cold-worked specimens. The effects of deformation after irradiation on the recovery spectra were studied on Cu, Au, and Al. In Cu, the recovery below 43°K was retarded, but this large retardation could not be observed in Al and Au. Two current mechanisms for the recovery stages are discussed in relation to these observations. For the recovery of Mo and W after neutron irradiation, the effects of radiation doping on recovery stages were studied. The radiation doping was found to increase the amount of stage I recovery in both Mo and W. The effects of radiation doping vanished in Mo when doped specimens were annealed above stage III, but not in W. This result suggests that the type of so-called stage III defects of Mo are different from those of W. The effects of deformation on the mixed state of superconductor (V) were studied and the flux line pinning by defects is discussed. (auth)

48450 (JAERI-M-4718) PREDICTION OF THE MECHANICAL BEHAVIORS OF COATED FUEL PARTICLES DURING IRRADIATION: CODE MICROS. Arai, Taketoshi (Japan Atomic Energy Research Inst., Tokyo). Mar 1972. 47p. (In Japanese). NTIS (U. S. Sales Only).

A mathematical model and computer code MICROS have been developed for predicting the mechanical behavior of coated fuel particles during irradiation. Features of the mathematical model include the following: calculations are possible up to five coating layers with the material properties arbitrarily specified; the stress and strain distributions can be calculated for each coating layer; the physical phenomena due to neutron irradiation introduced are fuel swelling, gas accumulation caused by fission process and chemical reaction, thermal strain, radioinduced dimensional change, and radioinduced creep; and fuel burnup and fast neutron dose rate can be specified separately as a function of the irradiation time, to simulate any irradiation conditions. The Code MICROS, incorporating numerical procedures for the above items, is written for both the CDC-6600 and FACOM 230/60 computers. The machine time is about 4 sec per time step with the latter computer. (auth) (Japan)

48451 (JAERI-Memo-4056) INTERNAL FRICTION MEASUREMENTS IN NEUTRON-IRRADIATED IRON AND IRON ALLOY. Watanabe, Katsutoshi; Matsushima, Eideo; Igata, Naohiro (Japan Atomic Energy Research Inst., Tokyo). Jun 1970. (In Japanese). NTIS (U. S. Sales Only).

A technique for internal friction measurements and the results of internal friction measurements on neutron-irradiated high-purity iron, pure iron, and iron–nickel alloys are reported. The internal friction measurements were performed by using the electromagnetic method of transverse vibration at 10^2 Hz. After irradiation of high-purity iron, the value of internal friction increased to $(1 \sim 2) \times 10^{-1}$. Snoek internal friction peaks were not observed in pure iron and iron–nickel alloys. The changes of Snoek internal friction peaks were observed after post irradiation annealing. The behavior of solute carbon and nitrogen and the role of alloying elements are discussed. (auth)

48452 (NAA-SR-Memo-9746) IRRADIATION QUALIFICATION TESTING OF SNAP 10A COMPONENTS. Chesavage, A. J. (Atomics International, Canoga Park, Calif.). 4 Feb 1964. Contract AT-11-1-GEN-8. 155p. Dep. NTIS. Declassified 3 Nov 1971.

Selected SNAP 10A components were irradiated to about 10^{14} NVT and 5×10^7 R at an average temperature of 136°F in a nominal vacuum of 2×10^{-5} torr. The components were operated periodically and the electrical characteristics recorded. Pre-irradiation and post-irradiation tests were conducted. Catastrophic degradation occurred only in the low-level neutron detection system at about 1.5×10^{13} nvt and in the high-level neutron power supply at about 6×10^{12} nvt. Marginal degradation occurred in the fusistors and in the silicone rubber insert material in connectors. The relays, low voltage trip devices, expansion compensator position demodulator, resistance thermometer sensor and bridge, and the gamma detection system operated within their respective specifications during and after irradiation. The insulation resistance of all components was adequate during and after irradiation. (auth)

48453 (NRL-7405) DAMAGE-FUNCTION ANALYSIS OF NEUTRON EMBRITTLEMENT IN STEEL AT REACTOR SERVICE TEMPERATURES. Serpan, Charles Z. Jr. (Naval Research Lab., Washington, D. C.). 8 Jun 1972. Contract AT(49-5)-2110. 17p. Dep. NTIS.

Neutron-induced increases in the brittle-ductile transition temperature (ΔTT) of A302-B pressure vessel steel have been measured from irradiations in a number of reactor environments for neutron fluences representative of pressure vessel design lifetimes. While these measurements have permitted formulation of the trends necessary for ΔTT projections in operating reactors, certain anomalous results have been observed wherein measurements fell outside the nominal limits of the trends. As a summation of research on this steel and to resolve the anomalous results, a damage function was derived for the neutron-induced ΔTT response of A302-B steel at reactor operating temperatures. The damage function is a series of weighting factors for the damaging capacity of neutrons of all energy groups in a reactor spectrum; these factors thus indicate the relative importance of specific energy-group neutrons to the damaging process. Techniques for derivation of the damage function and the complementing correlation-evaluation method are directly applicable to more advanced reactor systems. The damage function for transition temperature increase in A302-B steel irradiated at or near 550°F showed that neutrons of energies greater than 1 MeV would account for about 75 percent of the ΔTT. However, neutrons of energies greater than 0.10 MeV would account for well over 90 percent for virtually every spectrum evaluated. Thermal neutrons would contribute less than 5 percent of the ΔTT but only if the thermal neutron population were more than an order of magnitude greater than the fast (high-energy) neutron population. From this research, a method was developed for plotting neutron fluence (>0.183 MeV) weighted by the damage function that provides excellent correlation of the experimental 550 to 585°F irradiation data for diverse reactor environments. This method is a totally rational approach for correlating experimental radiation damage results, which has the advantage of being least susceptible to errors in flux spectrum and neutron dosimetry measurements. Damage function analysis is thus seen to be readily applicable for describing radiation damage effects in advanced and higher-temperature reactor environments. (auth)

48454 (ORNL-TM-3891) IRRADIATION EFFECTS ON SELECTED NERVA MATERIALS. Progress Report, September 1969–January 1970. Eatherly, W. P. (Oak Ridge National Lab., Tenn.). 24 Jul 1972. 47p. Dep. NTIS.

Pre-irradiation thermal conductivity and electrical resistivity measurements made with the Bulk Shielding Reactor (BSR) in situ apparatus are presented together with an analysis of errors for the system. The BSR neutron spectrum is compared with NERVA reflector spectrum as to the number of displacements produced in beryllium per neutron of energy greater than 1 MeV in the spectra. (auth)

48455 (ORNL-TM-3914) FINAL REPORT: THE EFFECT OF NEUTRON IRRADIATION AT CRYOGENIC TEMPERATURES AND SUBSEQUENT ANNEALING ON THE THERMAL CONDUCTIVITY AND ELECTRICAL RESISTIVITY OF BERYLLIUM. Williams, J. M.; Hinkle, N. E.; Eatherly, W. P. (Oak Ridge National Lab., Tenn.). Aug 1972. Contract W-7405-eng-26. 145p. Dep. NTIS.

A study of the effect of reactor irradiation at cryogenic temperatures on the thermal conductivity and electrical resistivity of beryllium was undertaken for the NERVA program. Thermal conductivity and electrical resistivity measurements were made in the longitudinal direction on cylindrical samples stationed in situ in the Liquid-Nitrogen-Cooled Cryostat of the Bulk Shielding Reactor. These properties were measured as a function of fluence to as high as 1.05×10^{19} neutrons/cm^2 (E > 1.0 MeV) at an irradiation temperature of ~110°K. Then, post-irradiation annealing studies exhibiting the kinetics of recovery and the temperature-dependency of the properties for the materials in various states between the irradiated state and the fully recovered state were made. On irradiation to 1×10^{19} neutrons/cm^2 the thermal conductivity of this beryllium decreases from 3.3 W/cm-°K to 0.67 W/cm-°K. The temperature region of most pronounced recovery is around 240°K. Complete recovery of properties characteristic of the unirradiated state is effected by room temperature annealing. (auth)

48456 (TRG-Report-2286) IRRADIATION CREEP IN A MATERIALS TESTING REACTOR. Lewthwaite, G. W.; Proctor, K. J. (United Kingdom Atomic Energy Authority, Dounreay (Scotland). Reactor Group). 1972. 34p. Dep. NTIS (U. S. Sales Only).

Helical springs made from titanium, zirconium, Nimonic PE 16 alloy, and two austenitic stainless steels, namely Firth-Vickers FV548 and a steel with a composition within the AISI 316 specification, have been irradiated in the Dounreay Materials Testing Reactor, at temperatures between 85 and 100°C and to neutron fluences up to about 4×10^{24} m^{-2} (>1 MeV), while loaded in tension. Irradiation creep was observed in all the materials studied and initial strain rates/unit stress per neutron ranged from 1 to $1.9.10^{-35}$ m^4 N^{-1} for Nimonic PE 16 and zirconium respectively. Data obtained from an earlier experiment are re-presented and compared with the present results. Springs which received no heat-treatment after coiling unwound during irradiation at rates which were independent of the supported loads. The phenomenon is attributed to the relaxation of internal stresses (produced during the manufacture of the springs) with an irradiation creep constant which is an increasing function of prior cold-work. A mechanism of irradiation creep is proposed which involves the re-arrangement of the dislocation network in a crystal as the dislocations climb by absorbing irradiation produced interstitials. (auth)

48457 VOID FORMATION IN FAST REACTOR MATERIALS. Bramman, J. I. (United Kingdom Atomic Energy Authority, Dounreay, Scotland); Nelson, R. S. Phys. Bull. (London); 23: 397-400(Jul 1972).

Prolific void formation occurs in cladding and structural components of fast reactors which are subjected to high dose levels of irradiation with high energy neutrons, ions or electrons. The phenomenon has potentially formidable influences on the dimensional and mechanical stability of the components. Data on the incidence of voids was acquired in the DFR at Dounreay, principally from examination of samples of cladding of experimental fuel pins irradiated to doses approaching 9×10^{22} neutrons/cm^2 in the temperature range 230 to 700°C by density measurement and transmission electron microscopy. V.E.C., a powerful particle accelerator, was used to simulate fast neutron-induced void formation and results from this were studied by transmission electron microscopy. The results from DFR and VEC were compared after normalization. Data showed that a higher dose is needed in cold worked material than in solution treated material to achieve a particular void size at a given temperature. As there were lower amounts of intragranular chromium carbide in the lower carbon steel M316L than in the higher-carbon steel M 316, it was concluded that suppression of chromium carbide would reduce the incidence of voidage. Nimonic PE16, with finely dispersed coherent precipitation, had much lower void concentration than that of other material samples. Void formation occurs when vacancies agglomerate to form three-dimensional cavities, and to reduce it there must be unsaturable traps for interstitial and vacancies within the solid. Such traps are dislocation lines, coherent precipitations and certain impurity atoms. (UK)

48458 EFFECTS OF NEUTRON IRRADIATION ON LONG-TERM STABILITY OF METALS AND X16H15 STEEL. Ilyasov, V. M.; Betekhtin, V. I.; Khudyakov, A. V. (Scientific Research Inst. of Atomic Reactors, Melekess, USSR). Trans. Iron Steel Inst. Jap.; 11: No. 4, 246-9(Jul 1971).

The effects of neutron irradiation (2.7×10^{20} n/cm^2, E ≥ 1 MeV at $T_{irr} - 150$°C) on time-to-rupture or rupture-life (τ) of aluminium, austenitic steel X16H15 and nickel (10^{21} n/cm^2, E ≥ 1 Mev at $T_{irr} = 150$°C) tested under uniaxial tension at different stresses (σ) and temperatures (T) were investigated. It was found that irradiation may lead to either an increase (for aluminium) or a decrease (for nickel and X16H15) in τ. The relation of time-to-rupture with rupture stress and test temperature for irradiated metals follows the equation stated in Zhurkov's papers earlier: $\tau = \tau_0 \exp (U_0 - \gamma\sigma/kT)$. The analysis of the parameters U_0 and τ_0 for metals revealed that the changes in τ after irradiation were not connected with the changes in the rupture mechanism and its kinetic thermal fluctuation character but stipulated by the irradiation effects on structure. It is suggested that neutron irradiation doesn't provoke changes in the rupture mechanism in the case of X16H15 at the elevated temperatures within the present experiment. (Japan)

48459 EFFECT OF IRRADIATION ON THE STRAIN RATE DEPENDENCE OF TYPE 304 STAINLESS-STEEL MECHANICAL PROPERTIES. Steichen, J. M. (Westinghouse Hanford Co., Richland, Wash.). Nucl. Technol.; 16: No. 1, 308-15(Oct 1972).

High strain rate tensile data have been obtained on Type 304 stainless steel which was irradiated in EBR-II to a maximum fluence of 0.7×10^{22} n/cm^2 (E > 0.1 MeV) at a temperature of approximately 950°F. Tests were performed over a range of strain rates from 3×10^{-5} to 1×10^{1} sec^{-1} at 800 and 1000°F to provide mechanical properties information for safety analyses for the Fast Flux Test Facility. The results of these tests demonstrate the strength of irradiated Type 304 stainless remains essentially constant with increasing strain rate and the ductility decreases with strain rate at a fluence of 0.2×10^{22} n/cm^2 and increases with strain rate at a fluence of 0.7×10^{22} n/cm^2. (auth)

48460 ESTIMATES OF CREEP-FATIGUE IRRADIATED AND UNIRRADIATED AUSTENITIC STAINLESS STEELS. Brinkman, C. R.; Korth, G. E.; Hobbins, R. R. (Aerojet Nuclear Co., Idaho Falls, Idaho). Nucl. Technol.; 16: No. 1, 297-307(Oct 1972).

Comparing data obtained from tests conducted on unirradiated Type 316 stainless steel in either the solution annealed or solution annealed and aged condition showed that aging was beneficial in improving both the fatigue and creep-fatigue properties at 593°C. An indication was found that unirradiated Type 304 stainless steel would be more suitable for applications involving creep-fatigue interaction than unirradiated Type 316. Irradiation to fluences of 0.17 to 6.1×10^{21} n/cm^2 E > 0.1 MeV (450°C) resulted in a pronounced effect on the creep-fatigue resistance of these materials when tested at a strain range of one percent. Both fatigue and creep damage values were calculated using actual times and cycles to failure and design times and cycles to failure. These damage values were summed linearly. Damage sums obtained were not found to be a unique value but dependent upon strain range, length of tensile hold time, and material condition. Comparisons between estimates of irradiated fatigue behavior and actual irradiated fatigue lifetimes were made using limited data. Estimates made using irradiated tensile data were usually found to be conservative in predicting pure fatigue behavior. (auth)

48461 POSTIRRADIATION CREEP OF ANNEALED TYPE 316 STAINLESS STEEL. Lovell, A. J. (Westinghouse Hanford Co., Richland, Wash.). Nucl. Technol.; 16: No. 1, 323-31 (Oct 1972).

The effect of fast-reactor irradiation on the creep behavior of annealed Type 316 stainless steel was reviewed and the interrelation between creep response and irradiation induced microstructure development analyzed. The effects of neutron fluence, irradiation temperature, and test temperaure on creep response were studied using illustrative examples. The results indicate that use of creep data from unirradiated specimens for design purposes overestimates strain expected during irradiation, except when a component is stressed at low temperature following high temperature irradiation. (auth)

48462 INTERRELATIONSHIP BETWEEN SWELLING AND IRRADIATION CREEP. Wolfer, W. G.; Foster, J. P.; Garner, F. A. (Westinghouse Electric Corp., Madison, Pa.). Nucl. Technol.; 16: No. 1, 55-63(Oct 1972).

The dimensional changes occurring in metals under fast neutron irradiation and external loads have been analyzed in terms of dislocation climb and glide, dislocation loop formation, and diffusional growth of voids. The strains produced by these mechanisms were derived. It is shown that although these strains can be divided into swelling strains and creep strains, the irradiation creep strains may be related to the swelling strains. Strains produced by the climb of dislocations only contribute mainly to swelling, but not to irradiation creep. However, if the glide of dislocations is controlled by the climb motion, the resulting irradiation creep rate is directly proportional to the swelling rate. Preferential loop nucleation induced by external stresses gives rise to an irradiation creep correlation which is in agreement with the experimental data. (auth)

48463 EFFECT OF NEUTRON IRRADIATION ON THE DUCTILITY OF AUSTENITIC STAINLESS STEEL. Bloom, E. E.; Weir, J. R. Jr. (Oak Ridge National Lab., Tenn.). Nucl. Technol.; 16: No. 1, 45-54(Oct 1972).

The effects of fast neutron irradiation on the tensile and creep-rupture ductility of austenitic stainless steels are presented. At low temperatures, below 450°C, radiation causes a reduction in the strain hardening exponent and thus the uniform strain. At high temperatures (above 750°C) reduced ductility results from helium embrittlement. At intermediate temperatures, hardening and helium effects act synergistically to produce lower ductility than would result from either effect alone. (auth)

48464 DAMAGE FUNCTION ANALYSIS OF AUSTENITIC-STEEL NEUTRON-INDUCED MECHANICAL PROPERTY CHANGE DATA. Simons, R. L.; McElroy, W. N.; Blackburn, L. D. (Westinghouse Hanford Co., Richland, Wash.). Nucl. Technol.; 16: No. 1, 14-24(Oct 1972).

Damage functions were determined for Type 304 stainless steel mechanical property changes in yield strength and total elongation for an irradiation and test temperature of ~480°C. The damage functions correlate the spectral effect of test reactor neutron induced changes in mechanical properties for subsequent use in predicting fluence limits for specified property level changes for reactor design studies. By propagating errors in the damage function analysis, a conservative lower bound fluence limit may be estimated. Results showed that the yield strength damage function was nearly the same as the displacement cross section used as the first approximation to the damage function. The total elongation damage function showed a high energy, >4 MeV, and low energy, $<10^{-3}$ MeV, enhancement of damage. Consequently, it is necessary to consider neutrons of all energies when correlating both fast and thermal test reactor data. (auth)

48465 ANALYSIS OF THE EFFECTS OF HYDROSTATIC STRESS ON SWELLING. Straalsund, J. L.; Guthrie, G. L. (Westinghouse Hanford Co., Richland, Wash.). Nucl. Technol.; 16: No. 1, 36-44(Oct 1972).

The effects of hydrostatic stress on void growth during irradiation have been studied using a diffusion model similar to that developed by Bullough and Perrin. Pressure effects were introduced into the theory via the boundary values assigned to the vacancy and interstitial concentrations in close proximity to voids and dislocations. It was concluded that at irradiation temperatures equivalent to the maximum swelling rate and above, the void growth rate increases linearly with hydrostatic tensile stress. Using estimated parameters for stainless steels no effect was found for temperatures below about 450°C. For constant structure, the stress effect was found to have the temperature dependence associated with self diffusion. The stress effect may be recognized as a form of Nabarro Herring creep and is therefore independent of damage rate. Stress effects could thus in principle be measured during postirradiation annealing experiments. Because of the uncertainties associated with many of the parameters incorporated in the swelling model, it was not possible to provide a reliable quantitative description of the effects of stress. (auth)

48466 SCIM, A THEORY BASED COMPUTER CODE FOR THE PREDICTION OF THE IN-PILE BEHAVIOR OF TYPE 304 STAINLESS STEEL. Harkness, S. D.; Grappel, R.; McDonald, S. G. (Argonne National Lab., Ill.). Nucl. Technol.; 16: No. 1, 25-35(Oct 1972).

A model for the behavior of Type 304 stainless steel during fast-reactor irradiation has been developed into the computer program SCIM (Swelling and Creep of Irradiated Metals). The model incorporates recent concepts on high-temperature radiation damage into an analytical tool for predicting in-pile behavior of Type 304 stainless steel. Swelling rates are discussed in terms of the relative efficiencies of voids and dislocations as sinks. The calculation for the swelling rate shows it is a maximum when the sink efficiencies are equal. The dose dependence of swelling is found to be a function of the relative rates of void and dislocation loop formation. Saturation mechanisms are discussed with respect to their effect on the swelling rate. Saturation is favored by increased void number density and increased irradiation temperature. This results in a compromise between irradiation temperature and the expected void volume at saturation. Cold work is expected to be increasingly effective with increasing irradiation temperature. At 372°C the dose dependence of swelling in cold-worked material is expected to be much higher than for solution-annealed material because of the rapidly changing relative effectiveness of voids and dislocations as point-defect sinks. High number densities of incoherent precipitate should limit swelling at intermediate irradiation temperatures by forming a saturation microstructure at low void volumes. A climb-controlled in-pile creep mechanism is discussed. The expression that results depend on the radiation-produced excess interstitial flux to glissile dislocations as the mechanism for enhanced in-pile creep. The glissile dislocations are created by the unfaulting of irradiation-produced interstitial dislocation loops. The principal obstacle is taken as dislocations pinned by the void structure. The maximum in-pile creep rate is expected to occur at nearly the same temperature at which swelling is a maximum. The creep rate is expected to slowly decrease with dose. (auth)

48467 IRRADIATION EFFECTS IN BORON CARBIDE PELLETS IRRADIATED IN FAST NEUTRON SPECTRA. Basmajian, J. A.; Pitner, A. L.; Mahagin, D. E.; Ripfel, H. C. F.; Baker, D. E. (Westinghouse Hanford Co., Richland, Wash.). Nucl. Technol.; 16: No. 1, 238-48(Oct 1972).

Fast neutron spectra irradiations of boron carbide are being performed. Hardened spectra irradiations in ETR, material irradiations in EBR-II, and EBR-II components yielded the data which are being used for design and analysis of FFTF control elements. Boron carbide was irradiated at temperatures from 800 to 1600°F at burnup values from 2×10^{20} to 20×10^{20} captures/cc. A variety of material parameters such as pellet density and boron to carbon ratios were measured. Data on gas release, swelling, thermal conductivity, microscopy and compatibility were found to differ substantially from data obtained in thermal reactors. (auth)

Other Materials

Refer also to abstracts 47860, 47992, 48331, 48403, 49792, 49815, 49991, and 49998.

48468 (BNL-50328) CONCRETE-POLYMER MATERIALS. Fourth Topical Report. Kukacka, L. E.; DePuy, G. W. (eds.) (Bureau of Reclamation, Denver, Colo. Brookhaven National Lab., Upton, N. Y.). Jan 1972. 126p. (REC-ERC-72-10). Dep. NTIS.

The development of three distinct types of concrete-polymer materials is described including polymer-impregnated concrete (PIC), precast portland cement concrete impregnated by a monomer system which is subsequently polymerized in situ; polymer-cement concrete (PCC), a premixed material in which monomer is added to a water-portland cement-aggregate mix and subsequently polymerized in place; and polymer-concrete (PC), a composite material formed by polymerizing a monomer and aggregate mixture. Concrete-polymer materials offer potential advantages of high strength and improved durability, as compared with conventional concrete. Results of investigations indicate that the most advanced concrete-polymer material for construction is PIC, which is now receiving the major emphasis in the program. Investigations are continuing with PC and PCC because these materials have many potential cast-in-place applications. Little success has been obtained with PCC. Several monomer systems were used to prepare samples and only epoxy resin showed limited promise of producing an improved concrete when considered on an increased compressive strength basis. However, high concentrations of epoxy are required. Progress has been made in the development of PC. Specimens produced by using methyl methacrylate (MMA) containing a silane coupling agent for improved bonding had polymer loadings of 5 to 6 percent and compressive strengths of 16,000 psi compared with strengths of 11,000 psi for samples without the silane. The monomer content of this material has been reduced to approximately that used in PIC. Survey experiments are being performed to select monomers for high-temperature applications such as would be encountered in desalting plants. Six monomer systems were screened and three-diallyl isophthalate (DAIP), MMA plus trimethylolpropane trimethacrylate (TMPTMA), and MMA plus ethyl-glycol dimethacrylate (EGDM) were selected for further evaluation. (auth)

48469 (BNWL-1495) EFFECT OF PRESTRESSING ON THE THERMAL EXPANSION AND YOUNG'S MODULUS OF GRAPHITE. Hart, Patrick E. (Battelle Pacific Northwest Labs., Richland, Wash.). Jun 1972. Contract AT(45-1)-1830. 32p. Dep. NTIS.

The effect of preloading on the thermal expansion behavior and elastic modulus of three grades of graphite was determined. Isostatic, compressive, and tensile preloading loading modes were used. The effect of loading was interpreted in light of the effect of changes in crack size and density. (auth)

48470 (DP-Report-499) BACON ANISOTROPY FACTOR AND CRYSTALLITE SIZES: MEASUREMENTS ON PYROCARBON

SPECIMENS. Project DRAGON. Tassone, G. (Atomic Energy Establishment, Winfrith (England)). Apr 1968. 22p. Dep. NTIS (U. S. Sales Only).

Because the use of pyrocarbon as deposited in fluidized beds for coating fuel particles is of considerable importance in the nuclear field, such as in the Dragon Reactor Experiment, it was important to characterize the pyrocarbon in terms of fluidizing conditions, i.e., gas flow, kernel charge, deposition temperature and resulting density, crystallite size L_c, and degree of preferred orientation or Bacon anisotropy factor (BAF). The crystallite size and BAF measurements currently done in Dragon by x-ray diffractometer are described, and a quick method for assessing the BAF is outlined. (P.C.H.)

48471 (DP-Report-562) MEASUREMENT OF HIGH TEMPERATURE IRRADIATION CREEP IN GRAPHITE. Project DRAGON. Blackstone, R. (Atomic Energy Establishment, Winfrith (England)). Aug 1968. 46p. Dep. NTIS (U. S. Sales Only).

As part of the joint Dragon/THTR graphite irradiation program, experimental techniques have been evolved for measuring the irradiation creep of graphite at high temperatures. The principle of the method is to restrain the irradiation induced dimensional changes to produce a stressed assembly which gives rise to irradiation creep phenomena in the different components. Its main advantage is that little irradiation space is required compared to techniques involving the use of direct loads. It was found that in the parts of a restrained assembly under irradiation a stress is built up which after a certain neutron dose reaches an equilibrium value. Measurement of this equilibrium stress enables the radiation creep constant of the graphite investigated to be calculated. Some general results are given for specimens strained in tension. (auth)

48472 (GULF-GA-A-12138) RESEARCH ON GRAPHITE. Annual Report, July 1, 1971–June 30, 1972, and Summary of Program Since Inception. Engle, G. B. (Gulf General Atomic Co., San Diego, Calif.). 15 Jun 1972. Contract AT(04-3)-167. 55p. Dep. NTIS.

The research project "Research on Graphite," is reviewed from its inception date April 1962 through the completion date June 30, 1972. Studies to modify and characterize the graphite microstructure, carbonization mechanisms of carbonaceous materials, fission-product release in fuel compacts, fabrication and irradiation of pyrolytic carbons, and the irradiation behavior of artificial reactor graphites are summarized. A qualitative interpretation of the high-fluence, high-temperature irradiation behavior of pyrolytic carbons and reactor graphites is given. (auth)

48473 (ORNL-TM-3889) IRRADIATION EFFECTS ON SELECTED NERVA MATERIALS. Progress Report, March–June 1969. Eatherly, W. P. (Oak Ridge National Lab., Tenn.). 24 Jul 1972. 43p. Dep. NTIS.

A program has been initiated to obtain the thermal and electrical conductances of beryllium and certain graphites of interest to the NERVA program. Equipment is under construction to permit irradiation at 80°K in the Bulk Shielding Reactor, simultaneous measurement of the desired physical properties, and subsequent annealing to 500°K. The initial apparatus showed excessive thermal gradients due to gamma-heating, and appropriate modifications are being made. Results are also given on dosimetry measurements, and thermal and electrical conductivities of unirradiated PO-3 graphite and Carbitex-700. (auth)

48474 COATING MATERIALS IN NUCLEAR POWER PLANTS. Schliesing, H. (Rheinisch-Westfaelisches Elektrizitaetswerk AG, Essen). Energie; 24: No. 3, 69-74(1972). (In German).

A discussion of the special features of coating paints for steel and concrete constructions in the conventional part of a nuclear power plant, and for steel and concrete constructions in the controlled area is presented. A description of the particular requirements and tests is also given. (GF)

48475 PREPARATION OF NEODYMIUM HYDROXIDE BY VAPOR-PHASE REACTION. Kuwano, Yasuhiko; Shiroki, Kenichi (Nippon Electric Co., Ltd., Kawasaki, Japan). J. Amer. Ceram. Soc.; 55: No. 7, 378(Jul 1972).

Neodymium hydroxide was prepared by heating Nd_2O_3 in H_2O vapor at pressures below 1 atm. The starting material was A-type hexagonal Nd_2O_3 prepared by calcination of neodymium oxalate. Studies on the final product showed that $Nd(OH)_3$ with a low bulk density, a small amount of uncombined water, and a distinct crystal structure was easily obtained by vapor-phase reaction. The product was used as the starting material for an Nd-doped YAG laser crystal. (P.C.H.)

48476 PREDEPOSITION OF BORON INTO SILICON BY THE USE OF B_2H_6. Hayashi, Yutaka; Yui, Naomasa; Tarui, Yasuo. Denki Shikensho Iho; 36: No. 1-2, 67-76(1972). (In Japanese).

The characteristics and mechanisms of the predeposition of boron into Si by using B_2H_6 as an impurity source are investigated. To attain reproducibility and uniformity of the sheet resistance values of the predeposited layer, it is proposed to use the solid solubility limit at the Si–Si–B compound interface. The Si–B compound layer on the predeposited Si surface is insoluble in the HF solution and is oxidized by hot HNO_3 or low temperature steam oxidation. Experimental data of the sheet resistance of predeposited layers ranging from several $\Omega/\square \sim$ few tens of $k\Omega/\square$ are presented, and the characteristics of the Si–B compound layer are studied. (auth)

48477 MELTING POINT DIAGRAM FOR THE SYSTEM $KCL-PbCl_2-UCl_4$. Desyatnik, V. N.; Mel'nikov, Yu. T.; Raspopin, S. P. (Ural Polytechnic Inst., Sverdlovsk, USSR). Izv. Vyssh. Ucheb. Zaved., Tsvet. Met.; No. 6, 102-4(1971). (In Russian).

Melting point diagrams were determined for the binary systems $KCl-UCl_4$ and $PbCl_2-UCl_4$. In the first two eutectics (562 and 335°C) and one compound $2KCl \cdot UCl_4$ were established; in the second system one eutectic (345°C) and one compound $4PbCl_2 \cdot UCl_4$ were found. A ternary melting point diagram was constructed for the system $KCl-PbCl_2-UCl_4$; three eutectics and two peritectic points were detected. (K.S.W.)

NUCLEAR MATERIALS AND WASTE MANAGEMENT

Accountability and Safeguards

48478 (BNL–16966) SOLUBLE THEORETICAL MODEL OF THE PROBABLE AMOUNT OF MATERIAL IN AN INVENTORY. Zucker, M. S.; Epel, L. G. (Brookhaven National Lab., Upton, N. Y.). Jun 1972. 20p. (CONF-720529–4). Dep. NTIS.

From thirteenth annual meeting of the Institute of Nuclear Materials Management; Boston, MA. (31 May 1972).

The concept of Markov chains, borrowed from probability theory, can be used to study various aspects of special nuclear material inventory control that are amenable to probabilistic treatment. As an illustration, a model of the operation of a storage vault or warehouse is set up which is soluble analytically, and yet is reasonably realistic. The inventory is assumed to have additions (receipts) and withdrawals (shipments) on a regular basis, and to have a periodic random selection of some of the items in inventory made for assay or testing. As a result of testing, it is assumed that knowledge of the content of individual items has been improved, narrowing the probability of deviation from the nominal value of such tested items. The inventory is thus composed of two populations with distinctly different levels of assurance associated with each. Using the model and the Markov theory, the time evolution of the probable content and assurance level of the inventory can be followed. (auth)

Disposal and Storage

48479 (ORNL-TM–3799) PLUTONIUM BURNING PROGRAM STATUS REPORT. Ulrich, W. C. (Oak Ridge National Lab., Tenn.). Jul 1972. Contract W-7405-eng-26. 62p. Dep. NTIS.

The pressurized aqueous combustion (PAC) process was used to burn a simulated waste containing blotter paper, cheesecloth, polyethylene, and rubber over a temperature range of 225 to 285°C, with system pressures between 800 and 1525 psig and air flow rates of 2.0 to 10.1 std liters/min. Combustion rates of 0.67 to 2.26 %/min were obtained, and volume reduction factors were conservatively estimated to be >120. Oxidation in the range of about 85 to 95% was usually sufficient to burn or solubilize practically all of the combustible material. The reaction as carried out in the experimental equipment is mass transfer controlled. Addition of a reflux condenser permitted operation at pressures nearer the vapor pressure of water at the temperatures of interest, and also improved the quality of the effluent. The effective life of the Alpha Waste Storage Facility of the proposed National Radioactive Waste Repository could be extended by as much as 30 years by using the PAC process to burn the combustible portion of the waste received there. A PAC system for this purpose would produce a present worth net saving of about \$9.7 million, based on a unit waste storage charge of \$5/ft^3; a present worth cost of about \$1.4 million was projected, based on an incremental operating cost for the Facility of \$2.64 per cubic foot of waste storage volume. (auth)

48480 (ORNL-TM–3878) PRELIMINARY STUDY OF THE STORAGE OF SOLIDIFIED HIGH-LEVEL RADIOACTIVE WASTES IN CONCRETE VAULTS. Perona, J. J.; Blomeke, J. O. (Oak Ridge National Lab., Tenn.). Aug 1972. Contract W-7405-eng-26. 25p. Dep. NTIS.

Concrete vaults offer a safe, reliable means of storing high-level solidified wastes for many decades until a method for the permanent disposal of these materials can be selected. A design study was made of vaults which utilized natural draft air cooling of wastes that were packaged in 6- and 12-in.-diam containers and enclosed in cylindrical steel sleeves. The optimal spacing for the containers was found to be the closest one considered practical, a pitch-to-diameter ratio of 1.25. Although a close spacing increases pressure drop, energy costs are trivial if fans are used. For practical purposes, minimum capital costs are a function of can size only, and are virtually independent of the heat-generation rate per can. Optimal entering air velocities range from 0.5 to 2 fps, increasing with can size and heat-generation rate. Vaults that are of optimal design and have a total storage volume of about 1.1 million ft^3 would be required to accommodate all the high-level solidified wastes expected to be generated in the United States through the year 2000, provided the wastes were initially stored for 10 years at the fuel reprocessing plants. (auth)

Handling Equipment and Procedures

48481 (BARC/I–149) SAFE METHOD FOR REMOVAL OF HEAVILY CONTAMINATED FILTERS FROM HOT CELL EXHAUST DUCTS. Sivaramakrishnan, C. K.; Jadhav, A. V. (Bhabha Atomic Research Centre, Bombay (India)). 1971. 8p. INIS.

Hot cells designed to handle a maximum of 10,000 Ci ^{60}Co equivalent in the Radiological Laboratories at Trombay, India, envisage chemical operations of Pu and other radioactive materials with large amounts of fission products. Filters are used in the exhaust lines, very close to the cells to retain the radioactive dust particles before the exhaust air travels in the duct. Replacement of such heavily contaminated filters with new ones necessitates a remote operation ensuring an airtight containment of the filters during removal. A suitable method is described for such an operation using cheap disposable aluminum boxes. (auth)

48482 (CONF-720903–1) REMOTELY OPERATED CREEP TESTING. Dismuke, S. E.; Rardon, L. G. (Oak Ridge National Lab., Tenn.). 1972. 14p. Dep. NTIS.

From twentieth remote systems technology conference; Idaho Falls, ID. (17 Sep 1972).

A creep machine was designed for hot cell use that minimized the profile so that a maximum number of units could be lined up per cell. To cut costs, as many of the necessary operations as possible are performed with master-slave manipulators. Minimum profile was achieved by using a tubular furnace hung on the upper section of the specimen stringer. By placing the weight pan in front of the specimen stringer, a master-slave manipulator could be used for most operations on the machine. Careful placement of machines allowed minimum separation and complete manipulator service without interferring with adjacent units. (auth)

48483 (COO–3019-1) SEMIANNUAL PROGRESS REPORT, SEPTEMBER 1, 1971–FEBRUARY 29, 1972. First, M. W.; Underhill, D. W.; Hall, R. R.; Baldwin, T. W.; Moeller, D. W. (Harvard Univ., Boston, Mass. Harvard Air Cleaning Lab.). Apr 1972. 34p. Dep. NTIS.

Progress is reported on the sodium aerosol program. The program is concerned with measuring sodium deposition rates in heat exchangers and centrifugal blowers unprotected by prefilters. Deposition occurs at predictable rates. Methods of cleaning heat exchanger tubes while in service with brief blasts of compressed nitrogen have been explored and found to be practical. Progress is also reported on studies of fission gas adsorption systems. A gas adsorption bed operated under pressure will lose a portion of the adsorbed gases in the event of an accidental rupture of the container and release of pressure. Theoretical and laboratory studies show that the fractional release of fission gases will be smaller than the ratio of the initial to the final bed pressure and that the fraction of krypton released will be greater than the fraction of xenon released under the same conditions. (auth)

48484 (DPSPU–71-124-4-A(Suppl.1)) SAFETY SUMMARY REPORT: PADUCAH DEMONSTRATION CASK (PACKAGING OF RADIOACTIVE AND FISSILE MATERIALS). Evans, J. E.; Langhaar, J. W. (comps.) (Du Pont de Nemours (E. I.) and Co., Aiken, S. C. Savannah River Plant). Jun 1972. Contract AT(07-2)-1. 33p. Dep. NTIS.

The safety of the Paducah cask for shipping spent fuel for reprocessing from the SEFOR reactor is evaluated with respect to compliance with AEC Manual Chapter 0529 (AECM 0529), Safety Standards for the Packaging of Radioactive and Fissile Material. The Paducah Demonstration Cask, which has been equipped with a new insert for SEFOR fuel, will be used for these shipments. (auth)

48485 (LA-DC–72-546) IMPROVEMENTS IN REMOTE METALLOGRAPHY IN INERT ATMOSPHERES. Jeffries, D. D.; Bender, J. H.; Johnson, K. A. (Los Alamos Scientific Lab., N. Mex.). 1972. 12p. (CONF-720903–6). Dep. NTIS.

From twentieth remote systems technology conference; Idaho Falls, ID. (17 Sep 1972).

The metallographic examination of experimental fast breeder reactor fuel has necessitated the development of reliable equipment and techniques to provide high quality results with increased productivity. Improvements in transfer systems, grinder-polishers, autoradiography, and photography techniques, and in the maintenance of inert atmosphere have been effective in meeting these requirements. (auth)

48486 (LA-DC-13156) WASTE MANAGEMENT IN A SMALL, WIDELY DISPERSED MOUNTAIN COMMUNITY. Emelity, L. A.; Garde, R.; Christenson, C. W. (Los Alamos Scientific Lab., N. Mex.). 1971. 25p. (CONF-720618-1). Dep. NTIS.

From 6th international conference on water pollution research; Jerusalem, Israel (18 Jun 1972).

The equipment and methods used at the three sewage treatment facilities in Los Alamos County, N. M., for handling commercial and residential sanitary wastes and the two industrial waste treatment plants at the Los Alamos Scientific Laboratory for handling radioactive waste solutions are described. The low- and intermediate-level radioactive industrial wastes are treated adequately by chemical precipitation, ion exchange, and fixation in cement. However, due to increasingly stringent effluent standards with respect to radioactivity and to an increased desire by the public to preserve the beauty of the area, an expanding effort is being made to meet and surpass regulations for effective effluent control. (L.C.L.)

48487 (LBL-998) NEW METHOD OF CONTROLLING RADIOACTIVITY IN LABORATORY WASTE WATER. Eno, Eugene; Walker, Robert J.; Salz, Paul (California Univ., Berkeley. Lawrence Berkeley Lab.). 17 Apr 1972. Contract W-7405-eng-48. 20p. Dep. NTIS.

A novel method of monitoring and controlling radioactive water from active waste sewers is presented. This method, developed to handle large flows, costs less, requires less space, and is more effective than the conventional "holding tank" method. Advantages, equipment details, and comparative economics are discussed. (auth)

48488 RADIATION PROTECTION CASING FOR HYPODERMIC SYRINGES. Bertoni, Bruno; Delfosse, Jean (to Commissariat a l'Energie Atomique). French Patent 2,071,038. 23 Aug 1971. Filed 16 Dec 1969. (In French).

A casing for storing hypodermic syringes and facilitating the injection of radioactive substances into patients without any risk to the operator is described. The system consists of a lead casing provided with a limited cavity and possessing a lid which slides laterally over the casing. A lower support in the cavity houses the body of the syringe. An upper support is provided which possesses an orifice having the same dimensions as the head of the body of the syringe. The syringe is introduced by opening the lid and maintained in position by closing the lid. The apparatus is also provided with a nut and bolt system and a device for holding the syringe in position. (France)

Transportation

Refer also to abstract 49806.

PARTICLE ACCELERATORS

Design, Development, and Operation

Refer also to abstracts 48074, 48184, and 49348.

48489 (COO–1760-5) SUMMARY REPORT ON CYCLOTRON UTILIZATION, OPERATIONAL ACHIEVEMENTS, AND IMPROVEMENTS DURING TWELVE MONTHS ENDING MAY 31, 1972. Technical Progress Report. (Washington Univ., St. Louis, Mo.). 15 Jul 1972. Contract AT(11-1)-1760. 45p. Dep. NTIS.

Operation, beam utilization, and improvements at the Washington Univ. 54-inch sector-focused cyclotron are described. The normal bi-weekly schedule is given, and a tabulation of the research uses of cyclotron time is included. Alpha particles, helium-3 particles, protons, and deuterons were accelerated. AEC funding, cyclotron expenses, and other income are discussed. (W.H.K.)

48490 (DNPL/R-13 (Vol.2)) DETAILED DESIGN STUDY FOR THE "NINA BOOSTER". VOLUME 2. (Daresbury Nuclear Physics Lab. (England)). 1972. 154p. Dep. NTIS (U. S. Sales Only).

The report is presented in eight chapters; assessment of the program "MAGNET" and its application to the design of synchrotron magnets (Hatton, V. W., Lauckner, R. J.), lattice and orbit calculations for the booster (Rabinowitz, I. I.), design of the magnet power supplies for the booster (Marks, N.), comparison of standing wave and travelling wave structures for acceleration in the booster (Saxon, G.; Hughes, E. A.), beam trajectories and tolerances for a six turn extraction system from NINA (Marks, N.), targetting, beam extraction and beam lines for the booster (Aitken, T. W.), experimental utilisation of the booster (Gabathuler, E.), and survey requirements for the booster (Stott, H.; Cook, J.). (UK)

48491 (KFK-EXT–18/72-1) OPERATION OF THE KARLSRUHE ISOCHRONOUS CYCLOTRON IN 1971. Schatz, G.; Schulz, F. (Kernforschungszentrum, Karlsruhe (West Germany). Zyklotron-Laboratorium). Apr 1972. 12p. Dep. NTIS (U. S. Sales Only).

The operation of the Karlsruhe Isochronous Cyclotron in 1971 is briefly described. The machine was shut down for half a year in order to install a new dee system and an axial injection system for polarized ions. (1 figure, 4 tables) (auth)

48492 (LBL–704) USE OF COLLECTIVE FIELDS IN THE ACCELERATION OF PARTICLES. Peterson, Jack M. (California Univ., Berkeley. Lawrence Berkeley Lab.). Feb 1972. Contract W-7405-eng-48. 18p. (CONF-720119–2). Dep. NTIS.

From American Physical Society meeting; San Francisco, CA. (31 Jan 1972).

Collective electric and magnetic fields arising from charges in beams and plasmas can reach very high intensities without spark breakdown and thus can be advantageous in the acceleration of particles. Three examples of collective-acceleration mechanisms are discussed; the collapsing pinch, nonlinear plasma waves, and the electron ring. (auth)

48493 (NP–19345) ANNUAL REPORT, 1971. (Daresbury Nuclear Physics Lab. (England)). 146p. Dep. NTIS (U. S. Sales Only).

An account is given of work during 1971 on the NINA and CERN programs; experiments with the synchrotron radiation facility, and the nuclear structure facility; and progress in computing and electronics, and health and safety. A list of publications is also included. (UK)

48494 (NP-19369) ANNUAL REPORT, 1971. (European Organization for Nuclear Research, Geneva (Switzerland)). 1972. 203p. Dep. NTIS (U. S. Sales Only).

CERN SYNCHROTRON—development in 1971
CERN II SYNCHROTRON—development in 1971
HIGH-ENERGY PHYSICS—research at CERN, 1971, (E/T)
NUCLEAR PHYSICS—research at CERN, 1971, (E/T)
RAD. DET., BUBBLE CHAMBER—development and research at CERN, 1971
STORAGE RINGS—development at CERN ISR, 1971
SYNCHROCYCLOTRONS—development at CERN, 1971 (R.W.R.)

48495 (RHEL/R–243) WORK OF THE RUTHERFORD LABORATORY IN 1971. Smith, J. R.; Telling, F. M. (eds.) (Rutherford High Energy Lab., Chilton (England)). May 1972. 223p. Dep. NTIS (U. S. Sales Only).

The annual report of the laboratory is presented under the following headings; divisional organization (December 1971); high energy physics (experiments using electronic techniques, bubble chamber experiments, nuclear structure experiments, theoretical high energy physics); instrumentation for high energy physics (instrumentation for the search for the intermediate boson, other instrumentation, electronic instrumentation, liquid hydrogen and deuterium targets, polarized proton target, the 1.5m cryogenic bubble chamber, special purpose magnets); accelerator operations and development (operation of Nimrod, the magnet ring power supply and ancillary plant, accelerator development, beam lines and associated equipment); applied research (superconducting magnet studies, superconducting synchrotron design studies, superconducting r.f. particle separator studies, fast cycling bubble chamber development, neutron beam research, satellite experiments); computer systems and applications (central computer system, on-line computer applications, data analysis and data handling); technical and administrative services (radiation protection, safety at the laboratory, support services, administration and public relations); and publications and lectures. (UK)

48496 PRELIMINARY MEASUREMENTS OF THE BEAM CHARACTERISTICS OF THE TANDEM VAN DE GRAAFF ACCELERATOR OF CISE. Caruso, E.; Colli-Milazzo, L.; Marcazzan-Braga, G. M.; Milazzo, M.; Nasini, M. (CISE, Milan. Univ., Milan). Energ. Nucl. (Milan); 19: No. 7, 470-2(Jul 1972).

Preliminary measurements of the beam characteristics of the Tandem Van de Graaff accelerator of CISE are described. The measurements were performed with a 6.5-MeV proton beam and a 9.9-MeV ^{3}He beam. (4 figures) (auth)

48497 VAN de GRAAFF ACCELERATOR AT CADARACHE AND THE ASSOCIATED EQUIPMENT. Hebert, D.; Arnaud, A.; Bluet, J. C.; Garnier, Y.; Pomelas, E. (CEN de Cadarache, Saint-Paul-les-Durance, France). Bull. Inform. Sci. Tech. (Paris); No. 168, 79-87(Mar 1972). (In French).

A description is given of this accelerator, its installation, and the equipment developed to improve its efficiency and performance. The utilization of an on-line computer, C11 90-10, is described. (France)

48498 FABRICATION OF A SUPERCONDUCTING LINEAR ACCELERATOR BY ELECTRON-BEAM WELDING. Johnston, A. E.; Cochran, R. R.; Hermannsfeldt, W. B.; Fritzke, G. P. (Stanford Univ., Calif.). pp 313-22 of Record of the 11th Symposium on Electron, Ion, and Laser Beam Technology. /Thornley, R. F. M. (ed.). New York; Inst. of Electrical and Electronics Engineers, Inc. (1971).

From eleventh symposium on electron, ion, and laser beam technology; Boulder, Colo. (12 May 1971).

The electron-beam welding of Nb was studied as part of the program to convert the Stanford Linear Accelerator to a superconducting accelerator. The construction and operation of a welder to provide test parts for this program are described. An analysis of the welds obtained is made. (10 figures) (R.W.R.)

48499 DEVELOPMENT AND APPLICATION OF A 1-MV, 1-MA MYLAR DIELECTRIC PULSED ELECTRON ACCELERATOR AND CONCEPTS FOR HIGH-ENERGY MODULAR GENERATOR SYSTEMS. Yonas, G.; Smith, I.; Spence, P.; Putnam, S.; Champney, P. (Physics International Co., San Leandro, Calif.). pp 421-32 of Record of the 11th Symposium on Electron, Ion, and Laser Beam Technology. /Thornley, R. F. M. (ed.). New York; Inst. of Electrical and Electronics Engineers, Inc. (1971).

From eleventh symposium on electron, ion, and laser beam technology; Boulder, Colo. (12 May 1971).

It has become apparent that requirements for higher output currents from pulsed electron-beam generators necessitate a modularization of machine components and the combination of the outputs from these separate generators. This modular approach has already been employed in the generators themselves; however, the next order-of-magnitude increase in output current will require the transport and combination of beams from separate generators. These two types of modularization and recombination are illustrated. The manner in which eight separate Mylar dielectric Blumleins can be combined to obtain 1.0 MA of output current from a single diode is described. Alternative schemes for beam transport and combination of beams from several such diodes are presented. Each of these techniques is described in terms of its advantages and limitations. (8 figures, 17 references) (R.W.R.)

48500 REBA: A PULSED ELECTRON BEAM GENERATOR. Johnson, D. L. (Sandia Labs., Albuquerque, N. Mex.). pp 445-

52 of Record of the 11th Symposium on Electron, Ion, and Laser Beam Technology. /Thornley, R. F. M. (ed.). New York; Inst. of Electrical and Electronics Engineers, Inc. (1971).

From eleventh symposium on electron, ion, and laser beam technology; Boulder, Colo. (12 May 1971).

A pulsed electron beam generator was designed and constructed and is now in operation at Sandia Laboratories. The generator, called REBA (Relativistic Electron Beam Accelerator), produced 45-kA beams of 3-MeV electrons in 70-ns pulses at the rate of 40 shots per day. A unique feature of REBA is that a single Marx generator can pulse charge either of two Blumlein transmission lines, and this provides two independent sources of electrons for experiments. The design considerations of the Marx generator, the Blumlein transmission lines, and the output tube are discussed. Preliminary electron beam measurements are also presented. (13 figures, 1 table) (auth)

48501 NRL RELATIVISTIC ELECTRON BEAM PROGRAM. Block, J.; Burton, J.; Frame, J. M.; (and others) (Naval Research Lab., Washington, D. C.). pp 513-26 of Record of the 11th Symposium on Electron, Ion, and Laser Beam Technology. /Thornley, R. F. M. (ed.). New York; Inst. of Electrical and Electronics Engineers, Inc. (1971).

From eleventh symposium on electron, ion, and laser beam technology; Boulder, Colo. (12 May 1971).

Two large electron beam generators, Gamble I and Gamble II, were designed and constructed at NRL. They are used for studies of the propagation of intense pulsed relativistic electron beams and the interactions of such beams with matter. Typical parameters of the electron beams produced are as follows: beam energy, 1 MeV; beam current, 1 MA; pulse duration, 40 ns. Gamble I is designed to produce beams of up to 20 kJ of kinetic energy; Gamble II, up to 60 kJ. The propagation of very-high-current relativistic electron beams ($\nu/\gamma \lesssim 10$) over distances of 1 m was studied as a function of drift-tube gas pressure and applied axial magnetic field. (10 figures, 1 table) (auth)

48502 BATAVIA PROTON SYNCHROTRON IN OPERATION AT 200 GeV. Com. Naz. Energ. Nucl., Notiz.; 18: No. 5, 41-9(May 1972). (In Italian).

The history and basic specifications of the 200-GeV accelerator, which reached peak design power March 1, 1972, are summarized. (15 figures, 2 tables) (auth)

Auxiliaries and Components

Refer also to abstract 48497.

48503 (GESSS-1) TOWARDS A EUROPEAN SUPERCONDUCTING SYNCHROTRON. (GESSS Collaboration (Group for European Superconducting Synchrotron Studies)). May 1972. 27p. Dep. NTIS (U. S. Sales Only).

Although the synchrotron now under construction at CERN has a design energy of 300 GeV, this can be increased to at least 1000 GeV by the use of superconducting magnets. The principal objective of GESSS (Group for European Superconducting Synchrotron Studies) is to coordinate work directed toward pulsed superconducting magnets and their application to future European accelerators. The first part of the report discusses the basic problems posed by the superconducting synchrotron, the present status of work of the GESSS collaboration, and the future GESSS program; long-range prospects for superconducting synchrotrons are included. The second part is devoted to technical aspects of the work. The present status of machine design and superconducting magnet development are discussed, the latter including conductor development, completed superconducting magnets, magnets under design and construction, and low-temperature properties of materials used in magnet construction. Magnet power supplies and refrigeration systems are also covered. (14 figures, 4 tables) (R.W.R.)

48504 (KFK-1372) AC LOSSES IN SUPERCONDUCTING PULSED MAGNETS. Ries, G.; Brechna, H. (Kernforschungszentrum, Karlsruhe (West Germany). Institut fuer Experimentelle Kernphysik). Jan 1972. 91p. Dep. NTIS (U. S. Sales Only).

The theory and calculation of ac losses in type II superconducting materials and superconducting coils are presented. The calculated losses are compared to loss measurements in solenoids performed by several laboratories. Methods of loss measurements are described. (22 figures, 3 tables) (auth)

48505 REDUCING THE ENERGY SPREAD OF THE EREVAN SYNCHROTRON INJECTOR. Esin, S. K.; Petrosyan, M. L.; Serov, V. L. (Inst. of Physics, Erevan). Izv. Akad. Nauk Arm. SSR, Ser. Fiz.; 6: No. 5, 398-401(1971). (In Russian).

A special demand arises on the traveling wave linear accelerators which are used as injectors for alternating gradient synchrotrons. The minimum of the energy spread is an item of the greatest importance. Operation of the first accelerating section is studied as a function of injection energy and level of hf-excitation of this section. Computer calculations, which were performed by using the Razdan-3, show preference for low-injection-energy operation. In this case the beam current in the narrow energy interval grows. Experimental results are in good agreement with theoretical calculations. (2 figures) (auth)

48506 SOME POSSIBILITIES OF FLAT TOP FORMATION IN TIME DEPENDENCE OF THE SYNCHROTRON MAGNETIC FIELD. Gusev, O. A.; Esin, S. K.; Lebedev, A. P.; (and others) (Inst. of Physics, Erevan). Izv. Akad. Nauk Arm. SSR, Ser. Fiz.; 6: No. 5, 402-8(1971). (In Russian).

Possible schemes for flat-top formation of the magnetic field in a synchrotron are considered. The results of calculations are illustrated with quantitative data for the Erevan synchrotron. The results of modeling of the schemes considered on a computer are given. (auth)

48507 HIGH-DOSE-RATE ELECTRON-BEAM IRRADIATIONS USING A TELESCOPING DRIFT TUBE. Schroeder, C. L. (Air Force Weapons Lab., Albuquerque, N. Mex.); Phillips, D. H.; Southward, H. D.; Grannemann, W. W. pp 89-92 of Record of the 11th Symposium on Electron, Ion, and Laser Beam Technology. /Thornley, R. F. M. (ed.). New York; Inst. of Electrical and Electronics Engineers, Inc. (1971).

From eleventh symposium on electron, ion, and laser beam technology; Boulder, Colo. (12 May 1971).

The application of basic well-known principles to the design of a telescoping drift tube is reported. An illustration with all of the necessary dimensions is presented so that other experimenters can fabricate similar drift tubes for use in their facilities. Deposition of high doses of ionizing radiation in short periods of time is a common requirement in radiation experiments. A flash x-ray (FXR) machine, when operated in the electron-beam mode, can be used to satisfy these requirements. This paper describes the design and operational characteristics of a telescoping drift tube developed for use with a 2.3-MeV FXR machine, the Febetron Model 705, manufactured by Field Emission Corp., McMinville, Oregon. However, the design concepts presented here can be used to improve the capability of other FXR facilities. (4 figures) (auth)

48508 REMOVING THE SPECTRUM DEPENDENCE FROM ELECTRON-BEAM DOSIMETRY MEASUREMENTS BY USING A MAGNETIC ELECTRON DEFLECTION TUBE. Phillips, D. H.; Grannemann, W. W.; Southward, H. D. (Univ. of New Mexico, Albuquerque). pp 93-102 of Record of the 11th Symposium on Electron, Ion, and Laser Beam Technology. /Thornley, R. F. M. (ed.). New York; Inst. of Electrical and Electronics Engineers, Inc. (1971).

From eleventh symposium on electron, ion, and laser beam technology; Boulder, Colo. (12 May 1971).

The low-energy portion of a flash x-ray machine electron spectrum is undesirable in that irradiation of test samples using low-energy electron beams complicates dosimetry calculations. The application of well-known basic principles in the design of a deflection tube which uses a 400-gauss magnet to deflect all low-energy ($E < 0.5$ MeV) electrons out of the horizontal electron beam is described. The remaining high-energy electrons can be used to irradiate test samples. If an electron beam contains no electrons with energies below 0.5 MeV, the absorbed dose in silicon semiconductor devices is directly proportional to electron fluence and independent of the electron energy spectrum. For $0.5 < E < 3$ MeV electrons, $\gamma(\text{rads(Si)}) = 2.6 \times 10^{-8}\ \Phi$ (electrons/cm^2) and $\dot{\gamma}(\text{rads(Si)/sec}) = 2.6 \times 10^{-8}\ \phi$ (electrons/cm^2-sec). The radiation output characteristics of the deflection tube and Febetron 705 flash x-ray (FXR) machine, results of electron-beam dosimetry calculations, optimum Faraday cup electron flux sensitivity, and optimum Faraday cup dose-rate sensitivity for electron-beam transient radiation effects on electronics (TREE) experiments are presented. (9 figures) (auth)

48509 INTENSE BEAM GENERATION AT MEGAMPERE CURRENTS AND BEAM TRANSPORT IN PULSED EXTERNAL MAGNETIC FIELD CONFIGURATIONS. Ecker, B.; Benford, J.; Stallings, C.; Putnam, S.; Spence, P. (Physics International Co., San Leandro, Calif.). pp 433-44 of Record of the 11th Symposium on Electron, Ion, and Laser Beam Technology. /Thornley, R. F. M. (ed.). New York; Inst. of Electrical and Electronics Engineers, Inc. (1971).

From eleventh symposium on electron, ion, and laser beam technology; Boulder, Colo. (12 May 1971).

Utilization of the energy available from low-impedance, fast-pulse generators requires development of low-impedance field-emission diodes with impedance lifetimes above 100 ns and of beam-transport and energy-density control techniques. Further scaling of generator systems to multimegampere current levels will involve generation of many separate electron beams or one large annular beam. Results of specific experiments related to electron-beam generation from single and double diodes and to electron-beam transport in both longitudinal and azimuthal external magnetic field configurations are presented. Most of the work was performed with two Mylar dielectric pulsed electron-beam generators, the 1.1-Ω, 350-kA PIML generator and the 1-Ω, 1-MV, 1-MA SNARK generator. (13 figures) (R.W.R.)

48510 DIGITAL COMPUTER SIMULATION OF HIGH-CURRENT, RELATIVISTIC, AND FIELD-EMISSION ELECTRON TUBES. Boers, J. E. (Sandia Labs., Albuquerque, N. Mex.). pp 527-34 of Record of the 11th Symposium on Electron, Ion, and Laser Beam Technology. /Thornley, R. F. M. (ed.). New York; Inst. of Electrical and Electronics Engineers, Inc. (1971).

From eleventh symposium on electron, ion, and laser beam technology; Boulder, Colo. (12 May 1971).

A digital computer program for the simulation of very-high-energy electron beams was written. The program can handle fairly complex cathode shapes and electron flows. The program includes space-charge effects through the solution of Poisson's equation and magnetic effects (both applied and induced) through the relativistic trajectory equations. Computations of the induced field permit cycloiding electron flows within the tube. The program employs relaxation techniques while alternately computing electric fields and trajectories. Execution time is generally less than 10 min on a CDC 6600 digital computer. Either space-charge-limited or field-emission cathodes may be simulated. Results obtained with the program are presented and compared with experimental results. (5 figures) (auth)

48511 NEW DIRECT-CURRENT POWER SUPPLY FOR THE BEAM-CONDUCTING MAGNETS OF THE CERN 28 GeV PROTON SYNCHROTRON. Jahn, K. (Siemens AG, Erlangen, Ger.); Rieger, E.; Steckmann, E. Siemens-Z.; 45: No. 7, 468-74 (1971). (In German).

A high current overload capacity, a minimum of ripple current, exact reproducibility of periodic current pulses and a high reliability during long-term operation are preconditions with regard to a modern current supply system for beam-bending magnets. These requirements can be met at justifiable costs by using efficient single-anode rectifiers and suitable electronic control and safety devices. (INIS)

48512 TECHNICAL PROBLEMS AS TO VIBRATIONS IN THE 95 MVA SURGE-POWER TRANSFORMER SET OF THE CERN 28 GeV PROTON SYNCHROTRON. Geissler, K.; Hoffmann, H. (Siemens AG, Erlangen, Ger.). Siemens-Z.; 45: No. 8, 529-39 (1971). (In German).

The beam-bending magnets of the CERN 28 GeV proton synchrotron are intermittently energized via rectifiers by a surge-power generator. Peak output values up to 70 MW are causing torque surges in the generator up to 10 kNm (100 mMp). The vibrations thus produced should not be transferred to the magnetic ring. In fact, the overall system poses quite interesting problems with regard to mechanics and dynamics, such as the vibration of the elastically fixed foundations and the torsional vibrations between the driving motor and the generator, due to intermittent operation and to a double-line short circuit either in the generator or motor. Vibration measurements during initial operation showed favorable results as to the operating behavior of the overall system and confirmed previous calculations. (INIS)

48513 95 MVA SURGE-POWER TRANSFORMER SET FOR THE BEAM-CONDUCTING MAGNETS OF THE CERN 28 GeV PROTON SYNCHROTRON IN GENEVA. Dressel, O. (Siemens AG, Berlin); Mueller, H.; Gross, S. Siemens-Z.; 45: No. 5, 356-61(1971). (In German).

Due to the load changes occurring within the range of seconds, with a peak power ±95 MVA, special requirements had to be met with regard to the layout of the transformer set for the beam-bending magnets of the 28 GeV proton synchrotron of CERN in Geneva. There was no need for an additional flywheel because of the design of the synchrotron generator which provides for an inertia moment of 41 tm^2 (flywheel action of 164 Mpm^2). Because of the continuous reversal of the torque at the generator shaft, it was thought appropriate to choose the reliable ridge-type construction of poles for the mounting of the poles, together with a grooved shaft. (INIS)

48514 ELECTROSTATIC ACCELERATED-CHARGED-PARTICLE DEFLECTOR. Maschke, Alfred W. (to United States Atomic Energy Commission). U. S. Patent 3,667,058. 30 May 1972. Filed 8 Apr 1970.

An electrostatic accelerated-charged-particle deflector includes a first electrode and a plurality of wire second electrodes spatially mounted with respect to each other and the first electrode to permit the passage of the accelerated charged particles between the first electrode and the second electrodes. A power supply is connected to establish a voltage gradient between the first electrode and the wire electrodes normal to the direction of motion of the charged particles to interact with them and deflect the charged particles. The potential gradient is established with the wire second electrodes being electrically positive in potential relative the first electrode. (2 figures) (auth)

48515 APPROXIMATE RELATION FOR THE PREDICTION OF THE DOSE RATE FROM RADIOACTIVITY INDUCED IN HIGH ENERGY PARTICLE ACCELERATORS. Sullivan, A. H. (European Organization for Nuclear Research, Geneva). Health Phys.; 23: No. 2, 253-5(Aug 1972).

In previous work (Sullivan and Overton, 1965) it was suggested that the dose-rate from radioactivity induced by high-energy particle radiation depended on irradiation time T and decay time t in a manner that could be expressed by: $D = K\phi\log(T + t)/(t)$ where ϕ is the flux density of high-energy particles causing the activation and K is a constant for any given set of irradiation, target and geometrical conditions. Values of K are estimated so that the formula can be used to make absolute dose-rate predictions of sufficient accuracy for radiation protection purposes. The assumptions made are considered and some examples of the value of K obtained for various geometries and irradiation conditions are given. It is concluded that dose rate predictions made with the theory proposed should only be considered as first approximations and errors are to be expected over limited time periods during radioactive decay. (UK)

48516 VSWR MEASUREMENTS OF LINEAR ACCELERATOR STRUCTURES BY A PHOTOGRAPHIC METHOD. Ohkubo, M. (Japan Atomic Energy Research Inst., Tokai). Nucl. Instrum. Methods; 103: No. 1, 53-9(1972).

A method of quick observation of VSWR (Voltage Standing Wave Ratio) of microwave components in a rather wider frequency range using a frequency modulated source and a photograph of multiple exposure is presented. The method was applied to the measurements of VSWR of the accelerating tubes of the JAERI linear accelerator, and the band pass character, the Brillouin diagram, and the group velocity were obtained. (auth)

Ion Sources, Injection, and Extraction

Refer also to abstracts 48490, 48497, 48523, and 49307.

48517 (N-72-17159) DEVELOPMENT OF REVERSE-BIASED p-n JUNCTION ELECTRON EMISSION. Final Report. Fowler, P.; Muly, E. C. (National Research Corp., Cambridge, Mass.). [1971]. Contract NAS1-8223-3. 58p. (NASA-CR-111985). NTIS.

A cold cathode emitter of hot electrons for use as a source of electrons in vacuum gages and mass spectrometers was developed using standard Norton electroluminescent silicon carbide p-n diodes operated under reverse bias conditions. Continued development including variations in the geometry of these emitters was carried out such that emitters with high emission efficiency (emitted current/junction current) were obtained. Pulse measurements of the diode characteristics were made and showed that higher efficiency can be attained under pulse conditions probably due to the lower temperatures resulting from such operation. (auth) (STAR)

48518 (SC-DC-721307) CHARACTERISTICS OF RELATIVISTIC FIELD EMISSION HIGH CURRENT DIODES. Bradley, L. P.; Parker, R. K.; Martin, T. H. (Sandia Labs., Albuquerque, N. Mex.). 1971. 6p. (CONF-720807-2). Dep. NTIS.

From fifth international symposium on discharges and electrical insulation in vacuum; Poznan, Poland (31 Aug 1972).

The observed behavior within the diode region of pulsed, low-impedance, high-current electron accelerators is shown to be consistent with the implications of the field emission, exploding whisker hypothesis of vacuum breakdown and with the concept of space charge-limited flow. Experimental techniques and results are described. (9 figures) (R.W.R.)

48519 BEHAVIOR OF LOW-IMPEDANCE, FIELD-EMISSION DIODES. Parker, R. K.; Anderson, R. E. (Univ. of New Mexico, Albuquerque. Air Force Weapons Lab., Kirtland Air Force Base, N. Mex.). pp 453-62 of Record of the 11th Symposium on Electron, Ion, and Laser Beam Technology. /Thornley, R. F. M. (ed.). New York; Inst. of Electrical and Electronics Engineers, Inc. (1971).

From eleventh symposium on electron, ion, and laser beam technology; Boulder, Colo. (12 May 1971).

The results of preliminary analysis of the time response of 1.5- and 2-in.-dia graphite cathodes demonstrated the field-emission character of this type of low-impedance diode. Approximately 10 ns after voltage was applied to the diode, cathode microprojections exploded to form cathode flares. The observed diode perveance for the remainder of the pulse was explained by postulating the movement of a "virtual" cathode formed by the merger of many flares. The plasma cathode was observed to move toward the anode at the constant velocity of 3 to 4 × 10^6 cm/s. The variation of the diode behavior as a function of several macroscopic parameters was found to be consistent with the concept of perveance and the implications of the field emission hypothesis of vacuum breakdown. (9 figures) (R.W.R.)

48520 DUOPLASMATRON AS A NEGATIVE HYDROGEN ION SOURCE. Aubert, J.; Dubarry, M.; Gautherin, G.; Septier, A. (CNRS, Orsay, France). pp 605-14 of Record of the 11th Symposium on Electron, Ion, and Laser Beam Technology. /Thornley, R. F. M. (ed.). New York; Inst. of Electrical and Electronics Engineers, Inc. (1971).

From eleventh symposium on electron, ion, and laser beam technology; Boulder, Colo. (12 May 1971).

A duoplasmatron with the extraction shifted in a direction normal to the axis of the discharge was constructed to study the effect of the various geometrical and electrical parameters on the beam obtained and to analyze the characteristics of this beam: its composition, energy spectrum, and emittance. The advantages of this type source over charge-exchange sources for currents of a few hundred μA include the following: the current is higher, the energy spread of the ions is narrower, the gas consumption is low, and the emittance is small. (7 figures, 2 tables) (R.W.R.)

48521 METAL ION SOURCE FOR ION IMPLANTATION SYSTEM. Shimizu, Keizo; Kawakatsu, Hisazo; Kanaya, Koichi (Electrotechnical Lab., Tokyo). Jap. J. Appl. Phys.; 11: No. 8, 1192-8(Aug 1972).

The source, which produces ions of both gases and solids, is of the oven-ionizer type, and the vapor pressure of 10^{-3} to 10^{-2} torr required for stable operation is obtained by heating the charge material to a sufficiently high temperature. A unique feature of this source is that the arc discharge formed in the source is constricted both geometrically and magnetically, thus allowing a large ion current, high brightness, and small spot size. The source was constructed in a testing system with a magnetic mass separator, and stable beams of Ar^+, He^+, N^+, Zn^+, Ag^+, Al^+, Au^+, and B^+ ions were obtained for long periods. The maximum ion current extracted from the source through 0.7-mm-dia outlet is more than 1 mA except when operated on pure boron, and the normalized brightness when operated on Ar is about 1.4×10^{11} A/cm^2 · strad. (auth)

Ion Optics and Field Calculations

Refer also to abstract 49000.

48522 (JINR-P9-6463) ADIABATIC PROCESSES IN THE HELICAL MAGNETIC FIELD. Bonch-Osmolovskii, A. G. (Joint Inst. for Nuclear Research, Dubna (USSR)). 1972. 17p. (In Russian). Dep. NTIS (U. S. Sales Only).

The motion of charged particles in self-focusing, azimuthal magnetic fields that vary adiabatically in time is considered in the linear approximation to the self-consistent field problem. It is shown that there exists an equilibrium configuration of particles in the form of a charged ring, and the law for small changes of its dimensions is found. In particular, at sufficiently large azimuthal field, the transverse dimensions of the ring vary as $1/\sqrt{H_\phi}$. (auth)

48523 (KFK-1564) FIXED POINTS OF SPECIAL NONLINEAR TRANSFORMATIONS OF BETATRON PHASE SPACE. Erb, J. (Kernforschungszentrum, Karlsruhe (West Germany). Institut fuer Experimentelle Kernphysik). Feb 1972. 78p. (In German). Dep. NTIS (U. S. Sales Only).

Thesis. Submitted to Technische Hochschule, Karlsruhe (West Germany).

The transverse motion of particles in an ideal synchrotron which is perturbed by a single sextupole is treated by transforming the phase plane over a number of revolutions. The perturbing sextupole is taken as a thin lens; consequently the transformation is given in the form of two algebraic expressions of the phase space coordinates. The fixed points of the transformation which are important for the stability behavior of the particles emerge from a system of algebraic equations. By using the group properties of the transformation and its symmetry the procedure of determining the fixed points is greatly simplified. It is shown that in the system under consideration the fixed points may be calculated analytically up to sixth order; they are given explicitly. The results can be used in designing slow extraction systems for particle beams from large synchrotrons. (auth)

48524 (KFK-1590) BEAM 72: COMPUTER PROGRAM FOR DEVELOPMENT OF BEAM TRANSPORT SYSTEMS. Juengst, W. (Kernforschungszentrum, Karlsruhe (West Germany). Institut fuer Experimentelle Kernphysik). Apr 1972. 43p. (In German). Dep. NTIS (U. S. Sales Only).

The computer program BEAM72 has the capability of adjusting variable parameters of beam channel elements such that specified properties of the system are obtained. Characteristics such as acceptance, dispersion, beam profile, individual particle paths, etc., can be computed. Because of its plotting routines, the program is particularly suitable for a comprehensive but easily surveyable presentation of system properties. Of the beam elements which are treated, the most essential are magnetic quadrupoles, magnetic dipoles (bending magnets), drift spaces, and diaphragms. (auth)

48525 (UCRL-Trans-1466) INSTABILITY OF VECTOR OSCILLATIONS IN THE ELECTRON RING ACCELERATOR. Zenkevich, P. R.; Koshkarev, D. G.; Perel'shtein, E. A. Translated by G. Brodel (Univ. of California Lawrence Berkeley Lab.), from a Russian Paper. 12p. Dep. NTIS.

The stability of the electron–ion ring as regards transverse bending ("snake-like") is studied, with the added parts to the electromagnetic field due to the finiteness of the ring radius of curvature taken into account. It is shown that a "single-beam" vector instability, connected with the quasi-static and radiation fields, can develop in the absence of ions in the electron ring. The expressions for the increment and the threshold of this instability were obtained. The behavior of the electron–ion ring, under the joint action of the "single-beam" vector instability and resonances of ion–electron oscillations, was studied. (auth)

48526 (UJV-2874-F) SYNCHRONOUS CYCLOTRON. Kuzmiak, M. (Ceskoslovenska Akademie Ved, Rez. Ustav Jaderneho Vyzkumu). Jun 1972. 2p. Dep. NTIS (U. S. Sales Only).

A relation for the static magnetic field in the equilibrium trajectory of the synchronous particle, which comprises also the radial velocity, is given. (auth)

48527 HYBRID COMPUTER-AIDED SYNTHESIS OF THICK ELECTROSTATIC ELECTRON LENSES. Ashley, J. R. (Univ. of Colorado, Colorado Springs). pp 157-66 of Record of the 11th Symposium on Electron, Ion, and Laser Beam Technology. /Thornley, R. F. M. (ed.). New York; Inst. of Electrical and Electronics Engineers, Inc. (1971).

From eleventh symposium on electron, ion, and laser beam technology; Boulder, Colo. (12 May 1971).

The synthesis of space-charge-free electron lenses can be approached by first assuming solutions for Laplace's equation in terms of cylindrical harmonics. The hybrid computer can quickly generate these assumed solutions and their gradient by working with the differential equations obtained from product separation of variables. The gradient is used in the integration for the trajectory to determine if the lens is useful. If it is, either equipotential surfaces or the potentials along a desired surface are generated with the computer to guide the physical realization of the lens. Certain cases in which space charge cannot be neglected are solved by truncation of rectilinear electron flow. Poisson's equation is solved in the computer to serve as a Cauchy boundary condition to Laplace's equation outside the electron beam. The hybrid computing technique and the experimental verification of some of the results in cathode-ray-tube electron lenses are presented. (9 figures) (auth)

48528 THIRD-ORDER ABERRATION COEFFICIENTS OF ELECTRON LENSES. Kuyatt, C. E. (National Bureau of Standards, Washington, D. C.); Natali, S. V.; Di Chio, D. pp 177-81 of Record of the 11th Symposium on Electron, Ion, and Laser Beam Technology. /Thornley, R. F. M. (ed.). New York; Inst. of Electrical and Electronics Engineers, Inc. (1971).

From eleventh symposium on electron, ion, and laser beam technology; Boulder, Colo. (12 May 1971).

In the standard treatments of aberration coefficients of electron lenses, deviations from perfect imagery are expressed as power series of the ray coordinates in the object and aperture planes. The resulting aberration coefficients depend on the object and aperture positions; and a complete description of the aberrations of a lens would, in principle, require a doubly infinite set of aberration coefficients. Verster has formulated the third-order aberrations of electron lenses in an object- and aperture-independent way for meridional trajectories and has determined some of the coefficients. By using highly precise numerical methods, electric fields and electron trajectories were calculated in the two-tube electrostatic lens for voltage ratios from 1.5 to 50, and all of Verster's third-order aberration coefficients were derived. (5 tables) (auth)

48529 COMPUTER ANALYSIS OF THE SPHERICAL ABERRATION OF THREE ELECTROSTATIC IMMERSION LENSES. Fraser, D. L. Jr.; Meyers, W. J.; Elser, T. G. (Dept. of Defense, Fort Meade, Md.). pp 209-18 of Record of the 11th Symposium on Electron, Ion, and Laser Beam Technology. /Thornley, R. F. M. (ed.). New York; Inst. of Electrical and Electronics Engineers, Inc. (1971).

From eleventh symposium on electron, ion, and laser beam technology; Boulder, Colo. (12 May 1971).

A theoretical computer analysis of three electrostatic, axially symmetric immersion lenses is presented. The focal properties of a flat-plate lens, a Crewe lens, and a hyperbolic lens are calculated. The focal properties of the flat-plate lens are shown to agree with published experimental and theoretical values. Further, the spherical aberration for finite object distances of three lenses is presented as a function of the lens configuration and object distance. The immersion lens designed by Butler for the Crewe gun is found to have the lowest spherical aberration coefficient of the three under the restrictions noted. (6 figures) (auth)

48530 THIRD-ORDER ABERRATIONS OF MAGNETIC ELECTRON LENSES. Heritage, M. B. (IBM Research Center, Yorktown Heights, N. Y.). pp 219-28 of Record of the 11th Symposium on Electron, Ion, and Laser Beam Technology. /Thornley, R. F. M. (ed.). New York; Inst. of Electrical and Electronics Engineers, Inc. (1971).

From eleventh symposium on electron, ion, and laser beam technology; Boulder, Colo. (12 May 1971).

Isotropic third-order aberrations of coma, astigmatism, field curvature and distortion were numerically calculated for a range of magnetic electron lenses. The cardinal points and the chromatic and spherical aberration coefficients were also derived. A comparison between the numerically derived coefficients and the values of Glaser is made in order to establish the error limits due to Glaser's assumption of a bell-shaped magnetic field. (8 figures, 1 table) (R.W.R.)

48531 ANALYTICAL SOLUTION OF THE AXIAL POTENTIAL FOR A THREE-ELEMENT ELECTROSTATIC LENS. Parks, H. G. (General Electric Research and Development Center, Schenectady, N. Y.). pp 229-38 of Record of the 11th Symposium on Electron, Ion, and Laser Beam Technology. /Thornley, R. F. M. (ed.). New York- Inst. of Electrical and Electronics Engineers, Inc. (1971).

From eleventh symposium on electron, ion, and laser beam technology; Boulder, Colo. (12 May 1971).

An expression for the axial potential that depends on only important lens dimensions and the electrode voltages is derived for the three-cylinder lens. This definition for the potential is valid for both symmetrical and asymmetrical lenses. The potential can be handled conveniently with numerical techniques to determine the first- and third-order lens properties in a fast, accurate manner. The usefulness of the potential is demonstrated by presentation of results and literature comparisons to verify the low computer time required and the accuracy of the properties obtained. (8 figures) (R.W.R.)

48532 COMPUTATIONAL STUDIES OF RELATIVISTIC ELECTRON BEAMS. Boris, Jay P.; Lee, Roswell (Naval Research Lab., Washington, D. C.). pp 535-52 of Record of the 11th Symposium on Electron, Ion, and Laser Beam Technology. /Thornley, R. F. M. (ed.). New York; Inst. of Electrical and Electronics Engineers, Inc. (1971).

From eleventh symposium on electron, ion, and laser beam technology; Boulder, Colo. (12 May 1971).

Numerical calculations of relativistic electron-beam and electron-ring phenomena are presented. The fully coupled set of Maxwell—Lorentz equations is solved for a large number of charged particles accelerated by their self-consistent and external electric and magnetic fields. Electromagnetic retardation effects are retained so that beam-related radiation effects are properly modeled. Results are presented on the expansion of infinitely long homogeneous relativistic beams with and without a magnetic guide field, the dynamics of beams with ν/γ both greater and less than unity, and the onset of inductively generated electron return currents in an inhomogeneous configuration where a strong electron beam propagates into a quiescent neutral background plasma. Partially neutralized relativistic electron rings are also considered. (15 figures) (R.W.R.)

48533 ACCELERATION OF IONS BY RELATIVISTIC ELECTRON-BEAM-FORMED PLASMAS. Graybill, S. E.; McNeill, W. H.; Uglum, J. R. (Ion Physics Corp., Burlington, Mass.). pp 577-84 of Record of the 11th Symposium on Electron, Ion, and Laser Beam Technology. /Thornley, R. F. M. (ed.). New York; Inst. of Electrical and Electronics Engineers, Inc. (1971).

From eleventh symposium on electron, ion, and laser beam technology; Boulder, Colo. (12 May 1971).

Recent experimental results on the acceleration of ions by pulsed electron beams to energies greater than the electron energy are presented. A theoretical model consisting of an accelerating potential well is discussed. (9 figures) (R.W.R.)

48534 COUPLED LENSES AND THEIR COMBINATIONS. Bliamptis, Emmanuel E. (Air Force Cambridge Research Labs., Bedford, Mass.). J. Appl. Phys.; 43: No. 9, 3696-3701 (Sep 1972).

Electric or magnetic quadrupole lenses and their thin lens analogues, or coupled lenses, are examined for double focusing. The compatibility conditions for double focusing are similar to the stability conditions of betatron oscillations. When the double-focusing conditions are satisfied, a quadrupole lens doublet or a pair of coupled thin cylindrical lenses is equivalent to a single thick converging lens with unequal focal lengths in two orthogonal meridian planes. Specific double-focusing examples are given and a nomogram is developed for facilitating the calculations when combinations of coupled lenses are considered. (auth)

48535 THIRD-ORDER TRANSFER MATRIX OF AN ELECTROSTATIC HEXAPOLE LENS. Taya, S.; Matsuda, H. (Osaka Univ., Toyonaka, Japan). J. Mass Spectrom. Ion Phys.; 9: No. 3, 235-45(Aug 1972).

The particle trajectory in an electrostatic hexapole lens is calculated in a third-order approximation for the purpose of correcting higher-order image aberrations of particle analyzers. From the symmetrical and antisymmetrical setting of six electrodes, the potential distribution is obtained as $\Phi = V(\xi^3 - 3\xi\xi^2)$. The calculated result of the particle trajectory is described in a third-order transfer matrix, and the matrix elements are given. (2 figures) (auth)

48536 THIRD ORDER TRANSFER MATRICES FOR THE FRINGING FIELD OF MAGNETIC AND ELECTROSTATIC QUADRUPOLE LENSES. Matsuda, H.; Wollinik, H. (Osaka Univ.). Nucl. Instrum. Methods; 103: No. 1, 117-24(1972).

Third order transfer matrices are derived for the fringing field of magnetic and electrostatic quadrupole lenses. All ion optical effects of the fringing field are reduced to a simple transformation at the ideal field boundary. The dominant third order elements are independent of the distribution of the fringing field. The other third order and the first order elements can be evaluated using the distribution function of the field gradient. The calculations are done in an effective fourth order approximation under the assumption that the extension of the fringing field is of about the same size as the beam diameter. (auth)

Storage Rings

Refer also to abstract 48494.

48537 (BNL-16793) ENERGY AVAILABLE WITH COLLIDING BEAMS. Blewett, J. P. (Brookhaven National Lab., Upton, N. Y.). 27 Jul 1971. 2p. Dep. NTIS.

The energy available for the creation of new particles in collisions between colliding beams is examined. It is shown, inter alia, that to equal the 400 GeV of energy available in ISABELLE, an accelerator bombarding protons at rest would require an energy of 85,300 GeV. (R.W.R.)

48538 (LA-4946) DESIGN STUDY FOR A MEDIUM-ENERGY, INTENSE, PROTON-STORAGE RING (WNR RING). Fullwood, Ralph R. (comp.) (Los Alamos Scientific Lab., N. Mex.). Jul 1972. Contract W-7405-eng-36. 53p. Dep. NTIS.

A design concept for a high-intensity, medium-energy proton storage ring to be used for weapons-related and basic physics research is presented. This racetrack-type, strong-focusing ring would accumulate 800-MeV protons up to currents of 100 A in the charge-exchange injection, low-duty mode. After bunching, this current would be extracted as a single 100-ns pulse. The high-duty mode accepts 25 turns of injected protons by a combination of orbit and tune shifting to achieve 60% phase density. In one configuration, the beam would be bunched into five 5-ns packets, each of which would be extracted separately at a rate of 600 pulses/s. This design uses the sector magnets of the Cal Tech synchrotron modified to be combined-function and strong-focusing. Each 180° bend is separated by a 15.74-m, $\pi-2\pi$ matched insert providing 7 m of clear drift. Extraction is by a 1° vertical kick of the beam into iron extraction septa. The design requires the particle energy to be less than the transition energy to avoid the "negative-mass" effect. An analysis of the ion-induced instability requires a vacuum of 10^{-9} torr; aluminum vacuum chambers are specified to reduce the resistive-wall effects. (49 figures, 15 tables, 115 references) (auth)

Experimental Facilities

Refer also to abstract 48090.

48539 (CERN–72-11) CERN MAGNETIC HORN (1971) AND ITS REMOTE-HANDLING SYSTEM. Dusseux, J. C.; Pattison, J. B. M.; Ziebarth, G. (European Organization for Nuclear Research, Geneva (Switzerland)). 4 Jul 1972. 21p. Dep. NTIS (U. S. Sales Only).

Considerable improvements have been made in the optical performance and technical reliability of the magnetic horn focusing device in the CERN neutrino beam facility since it was first installed. The arrangement as constituted in 1971 is described. Topics included are horn inner conductor, construction of the horn, stripline and polarity changer, connection between mobile and fixed installation, remote exchange facility for the horn, electrical characteristics of the horn system, monitoring devices and target support, performance, and future developments. (8 figures, 3 tables) (R.W.R.)

48540 (EGG–1183-1550) SELF-REPLENISHING TRITIUM TARGET. Jobst, J. E.; Burson, Z. G.; Haywood, F. F. (EG and G, Inc., Las Vegas, Nev.). 1972. 12p. (CONF-720607–25). Dep. NTIS.

From eighteenth annual American Nuclear Society conference; Las Vegas, NV. (18 Jun 1972).

In an attempt to construct a 14-MeV neutron generator yielding $\sim 10^{13}$ neutrons per second over a fairly long period of time, several schemes for trapping and/or conserving target gas were tried. Since no significant success was found in this way, a self-replenishing (during bombardment) target was constructed. A tritium reservoir was covered with a Pd–Ag foil, through which the tritium gas could pass. The foil was then covered with titanium. With beam heating, TiT formed on the surface and was constantly replenished to form a target of very long half-life. When the beam was shut off, the foil cooled and, like a valve, stopped the flow of tritium gas. Of three targets constructed, two performed quite successfully. It was found that yield seems to depend strongly on Ti thickness and slightly on foil thickness. The yield is not strongly dependent on T gas pressure; small variations in target temperature also appear inconsequential. (6 figures) (R.W.R.)

48541 (KFK-EXT–3/70-21) ESTIMATION AND OPTIMIZATION OF COSTS FOR BEAM HANDLING ELEMENTS. Hartwig, G. (Kernforschungszentrum, Karlsruhe (West Germany). Institut fuer Experimentelle Kernphysik). Mar 1972. 27p. Dep. NTIS (U. S. Sales Only).

The costs for beam handling elements are estimated for various design parameters. The cost for power supplies, cooling, or operation on optimization for some parameters, e.g., current density in the coils or the maximal magnetic flux density in the yokes, is given. The weight of iron and copper and the power consumption are summarized in tables for various magnets. (auth)

48542 (LA-DC–72-673) WNR: A NEUTRON TIME-OF-FLIGHT FACILITY AT THE LOS ALAMOS SCIENTIFIC LABORATORY. Moore, M. S. (Los Alamos Scientific Lab., N. Mex.). [nd]. 9p. (CONF-720631–2). Dep. NTIS.

From Feasibility and need for a high intensity pulsed and steady state fast neutron source conference; Las Vegas, NV. (17 Jun 1972).

The Weapons Neutron Research (WNR) facility will have 800-MeV proton beams in 500-μs pulses with a peak current of 17 mA at a repetition rate of 120 pulses per second. The H^- beam will be similar, but a factor of 10 lower in intensity. The beam will produce neutrons by striking a U target. As the resulting neutrons of highest energy will be strongly forward-peaked, the target will be viewed at 90° to the incident beam (the range of interest at the WNR facility is from 30 MeV down). The experimental program and proposed extension of the facility are described. (5 figures, 1 table) (R.W.R.)

48543 (RHEL/R–237) LIQUID HYDROGEN OR DEUTERIUM TARGET SYSTEM WITH CLOSED CYCLE REFRIGERATION. Mortimer, A. R.; Stokoe, J. R. (Rutherford High Energy Lab., Chilton (England)). Aug 1971. 84p. Dep. NTIS (U. S. Sales Only). UK 1.20 pound.

A liquid hydrogen or liquid deuterium target system has been developed for nuclear physics research which gives operational flexibility, employs modular re-usable equipment and possesses a high degree of safety. The system, using a proprietary closed cycle refrigerator, is capable of sustaining targets of up to 10 litres capacity at 20°K. Systems are in operation and working satisfactorily. (auth) (UK)

48544 MULTIPOSITIONAL TARGET CHAMBER FOR A NEUTRON GENERATOR. Viktorov, D. V.; Rozman, I. M.; Shcherbakov, A. M. This paper was summarized in At. Energ. (USSR); 31: No. 1, 49(Jan 1971) as paper No. 462/5581. (In Russian).

Full copy of this paper is held by TIC.

A multipositional target chamber and a method of cooling the target of a neutron generator are described. Sketches are given of the stainless steel target chamber, the water-cooled copper target holder, and a means of adjusting the angle of incidence of the deuteron beam. Control of heat flow and its planned distribution are discussed. (5 figures, 1 table) (K.S.W.)

48545 POSITIVE ION ACCELERATOR AND NEUTRON GENERATOR. Carr, B. J. (to Kaman Corp.). Canadian Patent 893,393. 15 Feb 1972.

A sealed neutron generator containing an isotope of hydrogen and having an ion source, accelerator and target is described. The target is maintained at ground potential and the generator operates from an alternating current source directly. Means are provided for selectively introducing an isotope of hydrogen into the generator. The unit is portable and provides rapid, high intensity pulses of neutrons. (Canada)

48546 METHOD OF MEASURING (p,n) THRESHOLDS FOR THE STUDY OF ACCELERATOR BEAM ANALYZING SYSTEMS. Afanas'ev, M. I.; Bortnyanskii, A. L.; Graevskii, A. I. This paper was summarized in At. Energ. (USSR); 31: No. 2, 141(Aug 1971) as paper No. 522/6150. (In Russian).

Full copy of this paper is held by TIC.

A system for automatically recording the yield of nuclear reactions is discussed. The energy of the incident particles is changed by modulating the potential on the target. As the potential increases, the channels of a pulse height analyzer are shifted by a current integrator. The yield of the nuclear reaction is recorded in the memory of the analyzer synchronously with the increase of the target potential. Excitation functions for the reactions ^{27}Al(p,n)^{27}Si and ^{13}C(p,n)^{13}N near threshold are shown. (3 figures) (R.W.R.)

48547 PRECISION GAMMA-RAY SPECTROSCOPY OF SHORT-LIVED NUCLIDES BY THE HELIUM-JET RECOIL-TRANSPORT METHOD. Bowman, W. W.; Sugihara, T. T.; Macfarlane, R. D. (Texas A and M Univ., College Station). Nucl. Instrum. Methods; 103: No. 1, 61-7(1972).

The helium-jet recoil-transport method, which has been used principally in α spectroscopy, has been modified for use in preparing short-lived sources in a form suitable for γ-ray spectroscopy. Reaction products recoiling out of a cyclotron-irradiated target are thermalized in helium and collected on the surface of magnetic tape. The collection site is in a low-background area 10 m from the target. The system includes circuits which control the source collection time, the transport and reproducible positioning of the source at a detector site, and the synchronized collection of γ-ray spectra as a function of time. Application of the method is illustrated by a coincidence study of the decays of 1.1 s ^{177}Hf^{m} and 4.3 s ^{178}Hf^{m} as produced by the ^{176}Yb(^{4}He,xn) reactions. Characteristics and limitations of the method are discussed. (auth)

48548 INDUCTIVE MEASUREMENT OF LOW-INTENSITY CHARGED PARTICLE BEAMS. Fois, M.; Morlot, F. (CEN, Fontenay-aux-Roses, France). Nucl. Instrum. Methods; 103: No. 1, 71-5(1972). (In French).

Two non-intercepting devices for intensity measurement of continuous charged beams are described; depending on required accuracy, operating range may be as low as $\approx 10^{-5}$A for the first one, ≈10^{-6}A for the other; both are transformer-type, flux integrating devices, taking advantage of the signal induced by setting-up or chopping-out the beam; high permeability magnetic cores with huge windings are employed, yet self-compensating techniques are required to prevent low-level signal integration over long times to be affected by the preamplifier's voltage offset; a description is given of two preamplifier-integrator self-compensated sets employing standard modules; a first very simple one and another achieving higher sensitivity through greater sophistication. (auth)

48549 300 KILOGAUSS IMPULSE MAGNET. Khakimov, S. Kh.; Lavrushkin, I. P.; Martemianov, V. P.; Ogurtzov, V. V.; Tarasenkov, V. G. (Kurchatov Atomic Energy Inst., Moscow). Nucl. Instrum. Methods; 103: No. 1, 135-9(1972).

The construction of an impulse magnet is described. The magnetic field distribution was measured in the working volume, and mechanical stresses in the coil body were calculated. Some simplifications were introduced in the calculation procedure. Test data of the magnet in the course of which 304 ± 15 kOe were obtained in the volume of about 1000 cm^3 are presented. (auth)

PHYSICS (ASTROPHYSICS AND COSMOLOGY)

Cosmic Radiation

Refer also to abstracts 48670, 48671, 48711, and 48768–48770.

48550 NORTH–SOUTH ANISOTROPY AND THE COSMIC-RAY GRADIENT IN THE VICINITY OF THE EARTH. Iucci, N.; Storini, M. (Univ., Rome. CNR, Rome). Nuovo Cim.; 10B: No. 1, 325-33(11 Jul 1972).

As was shown by Bercovitch, an estimate of the cosmic-ray radial gradient in the solar system can be obtained from the north–south (NS) anisotropy in interplanetary space. In the present analysis the neutron monitor data of the polar looking stations Alert (North) and McMurdo (South) in the years 1965–1968 (i.e. from the minimum to the maximum of solar activity) were used, omitting days of Forbush decreases and days of polarity inversion in the interplanetary magnetic field. The peak-to-peak NS anisotropy, which reverses its direction with the field polarity, is found to increase from (0.030 ± 0.025)% in solar minimum to (0.30 ± 0.03)% in solar maximum, while the estimated radial gradient increases from (0.4 ± 0.3)%/A.U. up to (4.2 ± 0.4)%/A.U. The implications of this result on the long-term modulation mechanisms are discussed taking into account the observed constancy in the solar-wind velocity throughout the investigated period. (auth)

48551 ROLE OF INTERSTELLAR GAS IN THE ANNUAL VARIATIONS OF COSMIC RAYS. Gidalevich, E. Ya. (Inst. of Geophysics, Sverdlovsk, USSR). Izv. Akad. Nauk SSSR, Ser. Fiz.; 35: No. 12, 2479-82(Dec 1971). (In Russian).

The peculiar motion of the Sun results in essentially axially symmetric steady-state flow of interstellar gas in the gravitational field of the Sun. From the use of an adiabatic approximation, the thermodynamic character of the gas was found. The calculated gas pressure is compared with the dynamic pressure of the solar wind. The ionization of the interstellar gas was established from the Sun's short-wave radiation, and its degree of ionization was found from the kinetic equations for ionization processes. The time of passage of the gas in the solar-radiation field is many times smaller than the ionization relaxation time. (tr-auth)

48552 PROPAGATION OF LOCALIZED SOLAR COSMIC RAYS. Lyubimov, G. P.; Kontor, N. N.; Pereslegina, N. V. Izv. Akad. Nauk SSSR, Ser. Fiz.; 35: No. 12, 2428-33(Dec 1971). (In Russian).

The nature and propagation of solar cosmic rays localized between a shock front and hot plasma, and ejected by a solar flare are discussed. Two aspects are elucidated, namely: the growth possesses a fine structure with a period of 4 to 7 h caused by spatial inhomogeneity in the field of localization of the solar cosmic rays; and the solar cosmic rays from out of the region of localization diffuse through the front of the shock wave. (tr-auth)

48553 ENERGY SPECTRUM OF PRIMARY COSMIC RAYS IN THE RANGE 10^{11} TO 10^{15} eV ACCORDING TO MEASUREMENTS MADE FROM THE ARTIFICIAL EARTH SATELLITE, PROTON-4. Akimov, V. V.; Grigorov, N. L.; Gubin, Yu. V.; (and others). Izv. Akad. Nauk SSSR, Ser. Fiz.; 35: No. 12, 2434-8(Dec 1971). (In Russian).

The α-particle energy spectrum of primary cosmic radiation was measured in the region 5×10^{10} to 1.6×10^{12} eV/nucleon from the artificial Earth satellite Proton 4. In this energy region, α-particle and proton spectra were similar and differed only in intensity. The absolute intensities of the α particles agreed well with low-energy data of other workers. (tr-auth)

48554 IRREGULARITIES IN THE SPECTRA OF PRIMARY COSMIC RAYS IN THE 10^{12}-eV REGION. Akimov, V. V.; Grigorov, N. L.; Mamontova, N. A.; (and others). Izv. Akad. Nauk SSSR, Ser. Fiz.; 35: No. 12, 2439-42(Dec 1971). (In Russian).

Spectra of primary cosmic rays in the energy region 10^{10} to 10^{14} eV were measured from the artificial Earth satellites Proton 1, 2, and 3. Thus, proton spectra (10^{10} to 10^{13} eV) and spectra of all particles in the 6×10^{10} to 10^{14} eV region were obtained. Protons comprise about half of all primary cosmic rays with energies of 10^{10} to 10^{11} eV. Therefore, for an increase in the spectral index for protons, there should be observed an irregularity in the form of a step in the spectrum of all particles. Certain defined functions relating to the energy and intensity are plotted in such a way as to reveal such irregularities in a pictorial manner. (K.S.W.)

48555 ENERGY SPECTRUM OF α PARTICLES OF PRIMARY COSMIC RAYS IN THE HIGH ENERGY REGION FROM DATA TAKEN BY THE "PROTON" SATELLITE. Grigorov, N. L.; Nesterov, V. E.; Prokhin, V. L.; Rapoport, I. D.; Savenko, I. A. Izv. Akad. Nauk SSSR, Ser. Fiz.; 35: No. 12, 2443-5(Dec 1971). (In Russian).

The measurement of the energy spectrum of primary cosmic ray particles in the range 10^{10} to 2×10^{13} eV/N from the "Proton" was facilitated by a special arrangement of detectors and scintillation counters, and the α particles were separated with the help of two proportional counters. The data are graphically depicted and discussed. (K.S.W.)

48556 GENERATION OF COSMIC-RAY NUCLEI OF SOLAR ORIGIN. Konyakhina, S. S.; Kurnosova, L. V.; Logachev, V. I.; (and others). Izv. Akad. Nauk SSSR, Ser. Fiz.; 35: No. 12, 2446-7(Dec 1971). (In Russian).

Data from eight occurrences of short-lived increases of flux of nuclei with a charge $Z > 20$ are presented. These observations were made during the flight of the satellite "Electron 4" and are compared with various phenomena of solar activity. (tr-auth)

48557 SCANNING FOR ANTIPROTONS IN PRIMARY COSMIC RADIATION. Bogomolov, E. A.; Lubyanaya, N. D.; Romanov, V. A.; Totubalina, M. G. Izv. Akad. Nauk SSSR, Ser. Fiz.; 35: No. 12, 2448-52(Dec 1971). (In Russian).

A magnetic spectrometer was used in an effort to detect an antiproton flux in primary cosmic radiation. The experiment was conducted in the summer of 1970 at an altitude of 30 to 32 km. An upper limit for the flux ratio of antiprotons/protons of 5×10^{-3} was obtained over the energy interval 2.3 to 5.3 GeV in primary cosmic radiation. (tr-auth)

48558 ULTRARELATIVISTIC COSMIC PLASMA. Ochelkov, Yu. P.; Prilutskii, O. F.; Rozental, I. L.; Shukalov, I. B. Izv. Akad. Nauk SSSR, Ser. Fiz.; 35: No. 12, 2453-7(Dec 1971). (In Russian).

The passage of high-density cosmic-electron beams was examined in strong magnetic fields. Equations were formulated and analyzed that describe such a process, and some partial solutions were obtained. The solutions obtained were used in interpreting the anomalies arising in the irradiation of some cosmic objects. (tr-auth)

48559 THEORY OF THE MODULATION EFFECTS OF COSMIC RAYS. Bagdasaryan, M. B.; Belov, A. V.; Dorman, L. I.; Shakhov, B. A. Izv. Akad. Nauk SSSR, Ser. Fiz.; 35: No. 12, 2492-7(Dec 1971). (In Russian).

A series of nonsteady-state and unsymmetrical models of the theory of modulation of cosmic rays are studied. Two partial cases of the problem with boundary conditions are investigated for a moving boundary. A model of the solar wind with some peculiarities in the spherical sector is examined. (tr-auth)

48560 REGION OF EFFECTIVE 11-YEAR MODULATION OF GALACTIC COSMIC RAYS (ACCORDING TO METEORITE DATA). Lavrukhina, A. K. (Inst. of Geochemistry and Analytical Chemistry, Moscow). Izv. Akad. Nauk SSSR, Ser. Fiz.; 35: No. 12, 2498-2502(Dec 1971). (In Russian).

The radioisotopic content of meteors was used to study the processes of modulation of galactic cosmic rays. The ^{37}Ar/^{39}Ar ratio was measured in four iron meteors, seven chondrites, and five iron-phase chondrites that had fallen in the years 1959–1970. The data indicated that the intensity of galactic cosmic rays with $E > 0.6$ GeV/nucleon at distances from one to two AU from the Sun varied with the solar cycle from the maximum to the mean by a factor of 1.8. Based on the ratio of ^{22}Na/^{26}Al, meteors in the time of complete revolution about the orbit are irradiated by unmodulated galactic cosmic rays. ^{54}Mn was used to determine the upper boundary of the domain of modulation. (K.S.W.)

48561 THREE-DIMENSIONAL ANISOTROPY OF COSMIC RAYS IN THE REGION OF LARGE AND SMALL ENERGIES. Dorman, L. I.; Eroshenko, E. A.; Inozemtseva, O. I. Izv. Akad. Nauk SSSR, Ser. Fiz.; 35: No. 12, 2503-7(Dec 1971). (In Russian).

Three-dimensional anisotropy of cosmic rays was studied, allowing for the energy spectrum according to daily variations in the nucleon component and its north–south asymmetry following the chromospheric flares on the Sun on September 21, 1967. Values of the cosmic-ray gradient in interplanetary space were calculated for the earth's orbit. In the range of strict cutoff between 1 and 13 GV, and for the period in question, the component gradient along three directions is small. The maximum value for the transverse gradient component did not exceed 4% AU. (tr-auth)

48562 EFFECTS OF ACTIVE ZONES OF THE SUN IN PROPAGATION OF GALACTIC COSMIC RAYS. Altukhov, A. M.; Krymskii, G. F.; Kuz'min, A. I.; (and others). Izv. Akad. Nauk SSSR, Ser. Fiz.; 35: No. 12, 2508-18(Dec 1971). (In Russian).

The influence of active zones on the behavior of cosmic-ray fluxes was studied in October to November 1968, and the observed results were compared with those calculated. The disturbed zone of interplanetary medium was investigated during a period of minimum solar activity, using the semi-diurnal variations of the neutron component of cosmic rays and the global network of stations. The disturbed zone possessed large lateral and longitudinal angular dimensions. Carrying out the magnetic structures from one active area is accomplished in the course of several rotations of the Sun. (tr-auth)

48563 SOLAR-DIURNAL, SPORADIC, AND ANNUAL VARIATIONS IN COSMIC RAYS. Gonchar, G. A.; Zusmanovich, A. G.; Kolomeets, E. V.; Chumbalova, R. A.; Shakhova, Yu. A. Izv. Akad. Nauk SSSR, Ser. Fiz.; 35: No. 12, 2519-24(Dec 1971). (In Russian).

Variations in isotropic and anisotropic fluxes with different periods for the period 1959 to 1969 were investigated using data on the neutron component of cosmic rays. A continuous spectrum of variations with periods of from 14 to 30 days was discovered, and annual variations in intensity were established. Their amplitude was dependent on the level of solar activity, decreasing from the maximum to the minimum of activity. Analogous variations were observed in indices of solar activity. Changes in the solar-diurnal variations were detected with periods of from 40 days to three months. The upper limit of the energy spectrum of anisotropy in the minimum of solar activity was 56 GeV, and that in the maximum of solar activity was 94 GeV. (tr-auth)

48564 DIFFUSION AND STOCHASTIC VARIATIONS OF GALACTIC COSMIC RAYS. Zusmanovich, A. G.; Kolomeets, E. V.; Shvartsman, Ya. E. Izv. Akad. Nauk SSSR, Ser. Fiz.; 35: No. 12, 2525-9(Dec 1971). (In Russian).

Two effects that arise during diffusion of galactic cosmic rays in the solar wind were examined. The first was the dependence of the beginning time of the maximum or minimum of the 11-year course of cosmic-ray intensity on the hardness of the particle. The second effect was the dependence of the position of the maximum in a particular spectrum of stochastic variations of cosmic-ray intensity on the dimensions of the area of modulation. (tr-auth)

48565 INTEGRAL MULTIPLICITY OF GENERATION OF THE NEUTRON COMPONENT OF COSMIC RAYS. Luzov, A. A.; Matyukhin, Yu. G.; Sdobnov, V. E. (Inst. of Terrestrial Magnetism, Ionosphere, and Radio-Wave Propagation, Novosibirsk, USSR). Izv. Akad. Nauk SSSR, Ser. Fiz.; 35: No. 12, 2583-6(Dec 1971). (In Russian).

The concept of integral multiplicity of generation aided in a demonstration of the possibility of calculating it for the neutron component of cosmic rays. The problem is resolved for nucleon and muon components of secondary cosmic radiation that made a basic contribution to the formation of neutron components. (tr-auth)

48566 COSMIC-RAY SPECTRUM AND PLASMA TURBULENCE. Tsytovich, V. N. (Lebedev Physics Inst., Moscow). pp 269-71 of Cosmic Plasma Physics. /Schindler, Karl (ed.). New York, Plenum Publishing Corp. (1972).

From Conference on cosmic plasma physics; Frascati, Italy (20 Sep 1971). See CONF-710951.

The main features of the observed cosmic-ray electron and ion spectra are considered as fundamental properties of cosmic rays. The question is posed whether it is possible to obtain from these properties any information about the physical parameters in the cosmic-ray sources. The modern theory of plasma turbulence is applied to this question. (W.D.M.)

48567 GALACTIC COSMIC-RAY DIURNAL VARIATION AS A STREAMING-PLASMA INTERACTION BETWEEN GALACTIC AND SOLAR CORPUSCULAR RADIATION. Kisselbach, V. J. (Max-Planck-Institut fuer Aeronomie, Lindau, Ger.). pp 349-50 of Cosmic Plasma Physics. /Schindler, Karl (ed.). New York, Plenum Publishing Corp. (1972).

From Conference on cosmic plasma physics; Frascati, Italy (20 Sep 1971). See CONF-710951.

Despite considerable experimental and theoretical attention, the diurnal variation in cosmic-ray intensity still poses many questions. In an attempt to clarify some of these problems, the phenomenon is considered to be an interaction between two plasma streams, one consisting of a galactic particle stream superposed on an otherwise diffuse galactic background, the other a solar plasma (solar wind). The analysis proceeds along the lines of usual plasma dynamics and leads to the result that a diurnal variation appears as a natural consequence of the interaction of these two plasma beams. The observed characteristics of this variation, viz., phase displacements associated with heightened solar corpuscular emission, the variation of amplitude and phase in the solar cycle, etc., follow naturally from this interpretation. Using data gathered with the Landau meson coincidence array, a quantitative check of the theory is carried out. (auth)

48568 INTERPLANETARY CONDITIONS ASSOCIATED WITH COSMIC RAY FORBUSH DECREASES. Barnden, L. R. (CNR, Rome). pp 351-8 of Cosmic Plasma Physics. /Schindler, Karl (ed.). New York, Plenum Publishing Corp. (1972).

From Conference on cosmic plasma physics; Frascati, Italy (20 Sep 1971). See CONF-710951.

New evidence is presented concerning the interplanetary phenomena which produce the Forbush decreases observed in the cosmic-ray intensity on Earth (1 to 60 GV). (W.D.M.)

48569 DIURNAL EFFECT OF COSMIC RAYS AND ITS DEPENDENCE ON THE INTERPLANETARY MAGNETIC FIELD. Bussoletti, E. (CNR, Rome); Iucci, N. pp 359-64 of Cosmic Plasma Physics. /Schindler, Karl (ed.). New York, Plenum Publishing Corp. (1972).

From Conference on cosmic plasma physics; Frascati, Italy (20 Sep 1971). See CONF-710951.

With a new method of analysis a "mean diurnal variation wave" was obtained utilizing data from fourteen neutron monitor stations for the period October 15, 1965 to June 30, 1966. In the same period of time magnetic data from Imp C were available, so that it was possible to investigate correlations between these observed cosmic-ray fluctuations and the corresponding observed changes of the interplanetary magnetic structure. Correlations between the phase of minimum, Φ_m, of the diurnal wave and the azimuthal direction of B, Φ_B, were examined. While it was not possible to reach a definite conclusion the study tended to confirm early qualitative results of Sarabhai and Sutramanian (1965) which suggested a positive correlation between Φ_m and Φ_B. A large part of the investigation was devoted to the morphology of the diurnal variation connected with the evolving magnetic structure of interplanetary space. From 1964 to 1966 the magnetic-sector boundaries show rather large differences over a scale of 0.1 AU. A comparison with results of Ryder and Hatton (1968) suggests that these sector-boundary changes in 1966 inhibit the "streaming fluxes" found to be present in 1964. The analysis shows strong discontinuities in the diurnal variation amplitude at the sector boundary edges which were not present in 1964. A semi-theoretical model to explain this phenomenon is given. The order-of-magnitude calculations obtained by this model agree well with the experimental results. (auth)

48570 COMPOSITION OF COSMIC-RAY NUCLEI AT HIGH ENERGIES. Juliusson, Einar; Meyer, Peter; Mueller, Dietrich (Univ. of Chicago). Phys. Rev. Lett.; 29: No. 7, 445-8(14 Aug 1972).

The charge composition of cosmic-ray nuclei from Li to Fe with energies up to about 100 GeV/nucleon was measured. A balloon-borne counter telescope with gas Cherenkov counters for energy determination was used for this experiment. The first results show that, in contrast to low-energy observations, the relative abundances change as a function of energy. It was found that the ratio of the galactic secondary nuclei to primary-source nuclei decreases at energies above about 30 GeV/nucleon. (auth)

48571 APOLLO 16 GEOCHEMICAL X-RAY FLUORESCENCE EXPERIMENT: PRELIMINARY REPORT. Adler, I. (Goddard Space Flight Center, Greenbelt, Md.); Trombka, J.; Gerard, J.; (and others). Science; 177: No. 4045, 256-9(21 Jul 1972).

The lunar surface was mapped with respect to magnesium, aluminum, and silicon as aluminum/silicon and magnesium/silicon intensity ratios along the projected ground tracks swept out by the orbiting Apollo 16 spacecraft. The results confirm the observations made during the Apollo 15 flight and provide new data for a number of features not covered before. The data are consistent with the idea that the Moon has a widespread differentiated crust (the highlands). The aluminum/silicon and magnesium/silicon concentration ratios correspond to those for anorthositic gabbros through gabbroic anorthosites or feldspathic basalts. The x-ray results suggest the occurrence of this premare crust or material similar to it at the Descartes landing site. (auth)

48572 ^{32}P INDUCED BY ATMOSPHERIC COSMIC RAYS IN LABORATORY CHEMICALS. Mabuchi, Hisao; Gensho, Reisuke; Wada, Yukio; Hamaguchi, Hiroshi (Tokyo Univ.). Geochem. J. (Nagoya); 4: No. 3, 105-10(Jan 1971).

Production rate of ^{32}P in rhombic sulfur was measured at various altitudes above sea level up to the top of Mt. Fuji, which is 3776 meters high. The production rate decreases exponentially with increasing atmospheric depth. This decrease indicates that the (n,p) reaction is predominant in ^{32}P production. From results of underground experiments, contribution of muons to the production of ^{32}P was estimated. Preparation of targets was made by recrystallization of sulfur from a CS_2 solution. This process was carried out just before exposure to cosmic rays. Duration of the exposure was about 1 month. After the exposure, the sulfur sample was dissolved in 6 liters of CS_2. The solution was refluxed for 2 hours with 1 liter of N HNO_3 containing 2 ml of Br_2 and 38 mg of PO_4^{3-} carrier. After separation of 2 layers, ammonium molybdate was added to the solution to precipitate ammonium phosphomolybdate. From the precipitate, ammonium magnesium phosphate was prepared, which was then dissolved with 0.1 N HCl. The phosphate was finally converted to $Mg_2P_2O_7$, which was subjected to radioactive measurement. (Japan)

48573 CROSS-SECTION OF SUPRATHERMAL PROTON BREMSSTRAHLUNG. Haug, Eberhard (Universtaet Tuebingen, Ger.). Astrophys. Lett.; 11: No. 4, 225-6(Aug 1972).

The suprathermal proton cross section is calculated for various values of the proton energy. The results are compared with previous work. (auth)

48574 ARE COSMIC RAYS PRODUCED BY WHITE DWARFS? Schoenfelder, V. (Max-Planck-Institut fuer Extraterrestrische Physik, Garching, Ger.); Truemper, J. Astrophys. Lett.; 11: No. 4, 203-6(Aug 1972).

The suggestion that magnetic white dwarfs might be the main source of cosmic rays in the Galaxy is discussed. It is shown that such a picture is incompatible with observations of the magnetic fields of white dwarfs and current theories on magnetic field decay. (auth)

48575 OBSERVATIONS OF THE RADIAL GRADIENT OF GALACTIC COSMIC RADIATION OVER A SOLAR CYCLE. O'Gallagher, J. J. (Univ. of Maryland, College Park). Rev. Geophys. Space Phys.; 10: No. 3, 821-35(Aug 1972).

More than 20 measurements of the heliocentric radial gradient in cosmic-ray flux have been made and reported between 1960 and 1971. These results are organized so that the important distinction between differential and integral measurements is emphasized and real discrepancies, some as large as 10 times the quoted errors, can be analyzed. Both integral and differential measurements above a few hundred million electron volts are most consistent with a positive gradient (increasing intensity for increasing radial distance) with a magnitude between a few per cent and a few tens of per cent per astronomical unit. On the other hand, below 100 MeV both integral and differential measurements are in wide disagreement, with no consensus even with respect to the sign of the gradient. Some factors that may contribute to these discrepancies are (1) the determination of a reference intensity to remove time variations, (2) the elimination of effects due to particles of solar origin, and (3) proper understanding of the effects of transient fluctuations in intensity. (auth)

Stars

Refer also to abstracts 48574, 49187, 49207, and 49349.

48576 (COO-3071-5) SIMPLE CALCULATION OF CRITICAL PARAMETERS OF NEUTRON STARS. Bludman, S. A. (Pennsylvania Univ., Philadelphia. Dept. of Physics). 20 Jun 1972. 17p. Dep. NTIS.

The instability of neutron stars comes about because of the softening of the equation of state for densities $\rho \approx 1$ to 4×10^{15} gm/cc. For soft equations of state, such as the independent-particle model, this happens when $\gamma_{(\rho)} = \rho dP/Pd\rho$ falls below $\gamma_{CR} \approx 4/3$ the critical value on Newtonian gravitational theory: the equation of state softens where the neutrons become special-relativistic. For stiffer equations of state, general relativity leads to instability at γ_{CR} values somewhat greater than $4/3$; nevertheless, the softening of the equation of state, for causality reasons or otherwise, is what brings $\gamma_{(\rho)}$ down below γ_{CR}. Particularly for relatively stiff equations of state, once $\gamma_{(\rho)}$ is approximately known in the region of densities about $\rho \approx 10^{15}$ gm/cm^3, the relativistic polytrope model considered in another paper (COO-3071-6) permits a quick estimate of the critical density, mass, and radius to about 20% accuracy. (auth)

48577 (COO-3071-6) STABILITY OF GENERAL RELATIVISTIC POLYTROPES. Bludman, S. A. (Pennsylvania Univ., Philadelphia. Dept. of Physics). 20 Jun 1972. 28p. Dep. NTIS.

Tooper's calculations of the parameters of the Lane-Emden functions for polytropes in general relativistic hydrostatic equilibrium are extended, particularly in the direction of greater incompressibility of the equation of state. The contraction of the nonrelativistic homology group when general relativity enters in is discussed. The stability limits for general relativistic polytropes are obtained. Letting $\sigma = (P/\rho c^2)c$ measure the effects of general relativity, for $\gamma - 4/3 \lesssim 7/5\,\sigma$ the polytrope $P = K\rho^\gamma$ will be unstable against radial collapse. Particularly if neutronic matter is stiff, these results will approximately determine the maximum mass and radius of massive neutron stars. (auth)

48578 CONDENSED π^- PHASE IN NEUTRON-STAR MATTER. Sawyer, R. F. (Univ. of California, Santa Barbara). Phys. Rev. Lett.; 29: No. 6, 382-5(7 Aug 1972).

It is argued that at some density, estimated at about 1 baryon/F^3, superdense nuclear matter will make a transition to a phase of approximately equal numbers of protons, neutrons, and π^- particles, the latter condensed in one or two plane-wave states of momentum $\approx$170 MeV/c. These conclusions are based on the conventional theory of the pion-nucleon interaction. (auth)

48579 STELLAR MAGNETOHYDRODYNAMICS. Mestel, L. (Univ. of Manchester, Eng.). pp 203-13 of Cosmic Plasma Physics. /Schindler, Karl (ed.). New York, Plenum Publishing Corp. (1972).

From Conference on cosmic plasma physics; Frascati, Italy (20 Sep 1971). See CONF-710951.

The outstanding features of the strongly magnetic stars are listed. Theoretical problems concerned with the oblique rotator model for these stars are considered; in particular, the origin of the slow rotations and of the large angles of obliquity between the rotation and magnetic axes, required to explain field reversal; and also why the magnetic star phenomenon appears confined to early-type stars. (W.D.M.)

48580 COMPLICATED GIANT BINARY, SX CASSIOPEIAE. Koch, Robert H. (Univ. of Pennsylvania, Philadelphia). Astron. J.; 77: No. 6, 500-12(Aug 1972).

The origin of the 1965-1967 cooperative observing campaign of SX Cas is based on obscurities or paradoxes in compiling older independent photometric and spectrographic studies. The journals of new or newly published astrometric, photoelectric, and spectrographic observations are given. Considerable attention was paid to the necessary matching of the supposedly standardized UBV observations contributed by individual observers. It is shown that the light curves, both within and outside the eclipses, are complicated by gas stream and ring effects and the hypothesis is explored that Rayleigh scattering of the A-star radiation pervades the system. It is suggested that such scattering may be the cause of the U-B excesses familiar for long-period binaries. Finally, an appreciation of the evolutionary condition of the binary is described and it is shown that differential evolution and mass exchange are not greatly advanced for this system. (auth)

48581 DWARF K AND M STARS IN THE SOUTHERN HEMISPHERE. Upgren, A. R. (Wesleyan Univ., Middletown, Conn.); Grossenbacher, R.; Penhallow, W. S.; MacConnell, D. J.; Frye, R. L. Astron. J.; 77: No. 6, 486-99(Aug 1972).

In the course of the near-complete Michigan Spectral Survey of the southern sky, 624 dwarf stars of type K2V and later have been identified. Many of these stars are previously unrecognized as nearby late dwarfs. The program, when complete, will extend the region covered by the McCormick lists of dwarf M stars to the entire sky. Spectral types are assigned which are based on the MK system. No systematic error in these classifications exists but the McCormick classifications are found to be systematically too late. A number of stars are within 20 pc of the Sun, which have not been included in catalogues of nearby stars. These account for less than 5% of the Oort limit for the total mass density in the solar neighborhood. (auth)

48582 POSSIBLE NEW MEMBERS OF A SUBGROUP OF THE SCORPIO-CENTAURUS ASSOCIATION. Glaspey, John W. (Univ. of Arizona, Tucson). Astron. J.; 77: No. 6, 474-85(Aug 1972).

Photoelectric uvby and Hβ photometric observations are presented for 117 A- and F-type stars in the region of the sky covered by the Scorpio-Centaurus association. The data are combined with previously published observations of B-type stars in the same region to discuss the possible membership of fainter stars in two subgroups of the association. With the aid of luminosity-sensitive photometric indices, the stars falling on or near the zero-age main sequence are labeled as "young," or "unevolved." Stars on this list which are subsequently found to have distance moduli falling in the same range as that shown by the early B-type stars, $5.3m \leq m - M \leq 6.7m$, are considered to be possible members of the association. Relative to the whole sample of stars studied in this way, the percentage of "unevolved" stars is appreciably larger than the corresponding percentage found in a sample of bright, field stars. This suggests that the photometric technique has found a significant number of new possible members of the Upper Centaurus subgroup. (auth)

48583 UBV AND $H\beta$ PHOTOMETRY OF OB STARS IN A MILKY WAY REGION IN NORMA. Drilling, John S. (Louisiana State Univ., Baton Rouge). Astron. J.; 77: No. 6, 463-74(Aug 1972).

Ninety-nine OB stars, 10 of which show $H\alpha$ in emission, were identified by means of an objective-prism survey in a region of 20 square degrees centered near $l = 330°$, $b = -2°$. $H\beta$ and UBV photometry was obtained for these stars and the color excesses and distance moduli of 96 of the stars determined therefrom. Heavy, variable absorption and OB stars apparently associated with the Sagittarius Arm are encountered at distances exceeding 1 kpc. The absorption is relatively low in the higher latitude portions of the field, and is found to show a dependence on z and sin b similar to that found in the solar neighborhood. Most of the stars were associated with two visual concentrations of OB stars previously noted by Lyngå. One of these, designated as Norma OB 1 in the Catalogue of Star Clusters and Associations, is shown to be a relatively young association located at 2300 pc from the Sun. The reddening was variable across this association, and an upper limit on the ratio of total to selective absorption of $R = 4.0 \pm 0.6$ (m.e.) was derived. The other concentration, located at $l = 332.0°$, $b = 1.1°$, is shown to be caused by two or more features seen in projection. An increase in the number of stars with $V_0 - M_V \geq 13.0$ per square degree with increasing galactic longitude across the field was attributed to the approach of the Norma–Scutum Arm to the Sun at these galactic longitudes. (auth)

48584 SECONDARY FLUCTUATIONS IN THE LIGHT CURVE OF ϵ AUR. Stub, H. (Univ. of Copenhagen). Astron. Astrophys.; 20: No. 1, 161-2(Aug 1972).

Color-dependent fluctuations in the light curve of ϵ Aur were found outside the eclipse. The maximum value of the amplitude equal to 0.2m occurred in the blue and ultraviolet. (auth)

48585 PHOTOELECTRIC OBSERVATIONS OF THE 1971-ECLIPSE OF 32 CYG. Gehlich, U. K.; Proelss, J.; Wehmeyer, R. (Hamburger Sternwarte, Hamburg). Astron. Astrophys.; 20: No. 1, 165-6(Aug 1972).

From photoelectric observations of the 1971 eclipse of 32 Cyg the time of mideclipse (JD_{hel} 2441256.8), the maximum duration of totality ($d \leqq 3$ days) and the spectral types of the components (B4V and K2Ib) were derived. (auth)

48586 UBV PHOTOMETRY OF o ANDROMEDAE. Olsen, E. H. (Lowell Observatory, Flagstaff, Ariz.). Astron. Astrophys.; 20: No. 1, 167-8(Aug 1972).

253 UBV observations of the shell star o And were made. The data did not show the eclipses with a period around 1.6d, which has been indicated by earlier observations. A possible period of about 1.018d was found. The evidence for the binary nature of o And is still very weak. (auth)

48587 CHEMICAL COMPOSITION OF ϵ PEGASI. van Paradijs, J.; de Ruiter, H. (Univ., Amsterdam). Astron. Astrophys.; 20: No. 1, 169-71(Aug 1972).

Spectra of the star ϵ Peg (K2Ib) were analyzed, using simple model atmospheres, in order to determine the effective temperature, gravity, and the chemical composition. The results were $\Theta_{eff} = 1.19 \pm 0.03$, and $\log g = 1.25 \pm 0.20$. It was found, as opposed to Warren's (1970; 1972) results, that ϵ Peg has a solar chemical composition. In particular, barium was found to be only marginally overabundant. In view of the uncertainties in the determination of the Ba abundance it seems premature to classify ϵ Peg as a barium star. (auth)

48588 PERIOD OF γ EQU. Renson, P. (Univ., Liege). Astron. Astrophys.; 20: No. 1, 173-4(Aug 1972). (In French).

The respective worths of the values 314 d and 1786 d for the period of γ Equ are weighed. The dispersion around a mean curve is smaller for the 1786 d period, but the photometric data seem rather to support P = 314 d. New measures are necessary to settle the right value of P. (auth)

48589 NON-THERMAL BREMSSTRAHLUNG OF FAST ELECTRONS AND FLARE OF STARS. Gurzadyan, G. A. (Byurakan Astrophysical Observatory, Erevan). Astron. Astrophys.; 20: No. 1, 146-9(Aug 1972).

In a previous paper the author presented a theory in which the optical flaring of stars was explained by assuming fast electrons appear spontaneously above the photosphere as a result of some kind of β-decay process, which then interact with infrared photons also present to produce the flare by the inverse Compton effect. Although the basic assumption of the existence of fast electrons is not at all proven, nevertheless, in the absence of a better flare star theory, the author in the present paper compares the amount of inverse Compton radiation with that of nonthermal bremsstrahlung also produced by the fast electrons. It turns out that the latter effect is practically of no significance, except for the very brightest flares observed. It is therefore concluded that, again if it can be shown that fast electrons are present, the optical flares in stars can be brought about by the inverse Compton effect alone owing to these electrons, which use less than one per cent of their energy for this process before passing into outer space. (auth)

48590 TIDAL PERTURBATION OF THE NON-RADIAL OSCILLATIONS OF A STAR. Denis, J. (Katholieke Univ., Leuven. Belg.). Astron. Astrophys.; 20: No. 1, 152-5(Aug 1972).

A generalization of the perturbation method in which the distortion of the equilibrium configuration is taken into account is applied to the perturbation of a gaseous star by tidal action. Numerical results are obtained in the case of an homogeneous configuration. These results show particularly that the stabilizing influence on unstable gravitational modes is smaller than in the case of a slow uniform rotation. It is also shown that the perturbation of the oscillation frequencies in the case of a synchronously rotating binary star can be obtained as a combination of the purely rotational and the purely tidal perturbation. It is found that the splitting of the modes belonging to the degenerate eigenvalue $\sigma^2/\pi G\rho_0 = 16/15$ is amplified by tidal action in a binary star component. The importance of this result for the interpretation of the beat phenomena in β Canis Majoris stars is discussed. (auth)

48591 STATISTICAL METHOD FOR THE DETERMINATION OF THE RATE OF CHANGES OF PERIOD FOR ECLIPSING BINARIES. van 't Veer, F. (Institut d'Astrophysique, Paris). Astron. Astrophys.; 20: No. 1, 131-4(Aug 1972).

A statistical treatment for the quantitative analysis of period changes ΔP for eclipsing binaries is given. The method can be applied to a series of measurements of minima times. It allows one to determine the rate of period change $\Delta P/\Delta t$ and also gives a test of the reality of sudden period changes of contact binaries. The method can only be applied to the best observed stars. Examples are given for SW Lac and 44i Boo. (auth)

48592 FAR-INFARED AND uvby PHOTOMETRY OF V 1057 CYGNI. Simon, Theodore; Morrison, Nancy D.; Wolff, Sidney C.; Morrison, David (Univ. of Hawaii, Honolulu). Astron. Astrophys.; 20: No. 1, 99-104(Aug 1972).

Four-color (uvby) photometry and broadband observations at 5, 11, and 20 μm are reported for V1057 Cyg (LkHα 190). The observations reveal a large flux excess superposed on the stellar continuum in the infrared. The color temperature of the excess decreases from about 2000°K at 2.2 μm to 200°K at 20 μm. On the assumption that the observed fluxes at 11 μm and 20 μm are due to thermal radiation from a cold, spherical dust shell, lower limits are obtained for the radius, mass, and kinetic energy of the shell. The derived values are compatible with the hypothesis that the shell was ejected from the star. The suggestion that the flux excess in the region 2 to 5 μm is due to circumstellar free–free emission is examined. Although this mechanism can account satisfactorily for the near-infrared observations, it appears to be incompatible with the energy distribution at wavelengths shorter than 5500 Å. The uvby photometry indicates that the brightness of V1057 Cyg decreased monotonically ($\Delta V \sim 0.15$m) from July 1971 to November 1971. The infrared flux at 10 μm and 20 μm has apparently also decreased. (auth)

48593 PHOTOMETRY OF NGC 3587, THE OWL NEBULA, IN H_α LIGHT, AND ITS STRUCTURE. Proisy, P. (Observatoire, Lyon). Astron. Astrophys.; 20: No. 1, 115-19(Aug 1972). (In French).

Isophotic contours of NGC 3587 in H_α light were derived from measurements on direct photographs secured with the 120 cm reflector of the Observatory of Haute Provence. (W.D.M.)

48594 LOCAL VOGT–RUSSELL THEOREM. Kaehler, H. (Hamburger Sternwarte, Hamburg). Astron. Astrophys.; 20: No. 1, 105-10(Aug 1972).

In the neighborhood of any given equilibrium configuration fulfilling the basic stellar structure equations, the "local" uniqueness of this solution can be investigated by linearizing the stellar structure equations. It is shown that the local uniqueness is guaranteed by the nonvanishing of the determinant of a 2×2 matrix, which is equivalent to the nonvanishing of the Henyey determinant. The connection with the stellar stability problem is discussed with the result that a local Vogt–Russell theorem holds for each star which is stable. (auth)

48595 SPECTRA OF TYPE I SUPERNOVAE. II. INTERPRETATION OF THE SPECTRA OF SN 1960 IN NGC 4496 FROM 8 TO 20 DAYS AFTER THE MAXIMUM OF LUMINOSITY. Gordon, Charlotte (Yeshiva Univ., New York). Astron. Astrophys.; 20: No. 1, 87-98(Aug 1972).

A study was made of the spectra of Type I Supernovae in an early stage of evolution. Identification of the absorption lines and construction of an empirical model showed the stratification of ionization. Identification of some emission lines as forbidden coronal lines was made. Their intensities were computed in the two cases of collisional or radiative ionization in the shell. The collisional ionization over a large volume seems to be ruled out by the observed stratification of the shell. The radiative ionization of the shell and approximative determination of T_e, of some abundances, and of the intensity of the ionizing radiation in the case of bremsstrahlung or synchrotron radiation were studied. The study seems to favor two models. In the first one the ionization is by absorption of bremsstrahlung and uv lines formed in the inner layers of the shell heated by absorption of low-energy radiation or by thermalization of low-energy protons and relativistic electrons. In the second one the ionization is due to an incident synchrotron radiation formed around the neutron star. The coronal lines can only account for a part of the intensity observed in the visible. A large contribution must come from He I, C III, C II, and Fe II permitted lines formed in the outer layers of the shell. (auth)

48596 SPECTRA OF TYPE I SUPERNOVAE. I. GENERALITIES. Gordon, Charlotte (Yeshiva Univ., New York). Astron. Astrophys.; 20: No. 1, 79-85(Aug 1972).

A preliminary study was made of the physical conditions existing in a supernova shell: mechanism of formation of the emission and absorption lines, construction of a density model and determination of the electronic density at the time of the maximum of luminosity. Review of the possible mechanisms of heating and ionization in the shell with a description of Sobolev's method was used to compute the line intensities. A tentative identification of the lines present in the spectra 20 days, 79 days, and 275 days after the maximum of luminosity is proposed. (auth)

48597 PHOTOELECTRIC LIGHT CURVE OF NOVA VULPECULAE 1968 N. 1. Tempesti, P. (Osservatorio Astronomico, Teramo, Italy). Astron. Astrophys.; 20: No. 1, 63-8(Aug 1972).

115 photoelectric observations in V light performed at the Teramo Observatory together with the observations so far published by other observers yield the light curve of Nova Vulpeculae 1968 N 1 from the outburst to August 1970. The star is confirmed to be a regular fast nova and the phases of decline show a connection with the spectral evolution in very close agreement with the normal correlation (McLaughlin, 1960). The decline follows a law of the type $L = at^{-c}$, a and c being positive constants assuming three different pairs of values which change abruptly in different parts of the light curve. The B−V color curve is also given and finally the absolute magnitude and other characteristic parameters of the nova are derived. (auth)

48598 EXAMPLES OF MULTIPLE SOLUTIONS FOR EQUILIBRIUM STARS WITH HELIUM CORES. Roth, M. L.; Weigert, A. (Hamburger Sternwarte, Hamburg). Astron. Astrophys.; 20: No. 1, 14-18(Aug 1972).

The different types of equilibrium configurations are discussed for stars with He cores and hydrogen-rich envelopes. As an example, a star of given mass and chemical composition is treated for which up to six solutions are shown to exist. The Henyey determinant H vanishes, i.e., infinitely neighboring solutions exist, when He-burning equilibrium models of $9M_\odot$ become secularly unstable. Real stars avoid this by appreciable ϵ_g values which keep H always finite. (auth)

48599 INFLUENCE OF THE OPACITY VALUES ON STATIC STELLAR MODELS. I. HORIZONTAL BRANCH STARS. Refsdal, S.; Stabell, R. (Hamburger Sternwarte, Hamburg. Univ. of Oslo). Astron. Astrophys.; 20: No. 1, 19-28(Aug 1972).

A method is presented whereby the effect of opacity changes in different regions of static stellar models can be discussed. The method is applied to horizontal branch stars, and the effect on the luminosity and the effective temperature is discussed in detail. (auth)

48600 ORBITING ASTRONOMICAL OBSERVATORY: REVIEW OF SCIENTIFIC RESULTS. Code, Arthur D.; Savage, Blair D. (Univ. of Wisconsin, Madison). Science; 177: No. 4045, 213-21(21 Jul 1972).

Scientific results obtained by the Wisconsin experiment package on board OAO-2 are reviewed. Included in the review are results of ultraviolet observations of stars, comets, planets, interstellar dust, interstellar hydrogen, objects with ultraviolet emission lines, Nova Serpentis 1970, galaxies, and variable stars. (auth)

48601 RATE OF STAR FORMATION. Einasto, Jaan (Astrophysical Observatory, Tartu, Estonia). Astrophys. Lett.; 11: No. 4, 195-9(Aug 1972).

Formulae are found for the time derivative of the projected density and the total mass of stars in a galaxy, supposing for the local rate of star formation the relation $R_1 = \gamma\rho_g^n$, where ρ_g is the density of interstellar gas, and γ and n are parameters. It is shown that for $10^{-2} < \rho_g < 1M_\odot\ pc^{-3}$ the parameters have the values n = 2 and $\gamma = 4M_\odot^{-1}\ pc^3\ (10^9\ yr)^{-1} = 2 \times 10^6\ cm^3\ g^{-1}\ sec^{-1}$. (auth)

48602 INFRARED PHOTOMETRY OF HBV 475 AND MHα 328-116. Knacke, R. F. (State Univ. of New York, Stony Brook). Astrophys. Lett.; 11: No. 4, 201-2(Aug 1972).

HBV 475 and MHα 328-116 were observed at 3.5, 11.7, and 22 μm. The strong infrared emission from both objects is similar to that observed from planetary nebulae and symbiotic stars. (auth)

48603 EVOLUTION OF THE ELEMENTS. Fowler, P. H. (Univ. of Bristol, Eng.). Proc. Roy. Soc. (London), Ser. A; 329: No. 1576, 1-16(18 Jul 1972).

A brief account of nuclear structure and of the work of Rutherford and his colleagues is followed by a review of current information concerning the evolution of the elements now forming the Earth. It is shown that the necessary conditions have not existed either on the Earth or in the Sun. Before the formation of the solar system, various active stars in this neighborhood are presumed to have enriched the interstellar gas with their contribution of matter through nuclear synthesis—including relatively small quantities of the heavy products that are synthesized by the r and s processes of successive neutron capture. These stars themselves are expected to emit mainly C, O, Si, Fe, etc. Their neutron baths will have irradiated only a small part of their material. The cosmic-ray distribution gives a guide to the elements that a supernova might throw out the interstellar gas. The solar system and other stars then are presumed to have formed as a result of the condensation of such a gas and dust cloud. A study is being made of this matter which has had a complex evolution, some of it perhaps having been part of many stars before, and part, the H and He component perhaps, having yet to enter its first star. (U.K.)

48604 NON-SPHERICAL NEBULAE OF NOVA DELPHINI 1967, NOVA VULPECULAE 1968(1), AND NOVA SERPENTIS 1970. Hutchings, J. B. (Dominion Astrophysical Observatory, Victoria, B. C.). Mon. Notic. Roy. Astron. Soc.; 158: No. 2, 177-98(Jul 1972).

The nonspherical distribution of ejected matter in the nebular stages of novae is discussed in terms of the assumed binary nature of the central stars. A hypothesis is proposed, by which the nonspherical distribution may be formed, and which may explain most of the general features of the nova phenomenon. The nature of line profiles formed by nonspherical ejecta is discussed and illustrated. New spectrophotometric observations are presented of the later stages of three recent novae, and models are derived for their postmaximum and nebular stages, in terms of the foregoing discussion. (auth)

48605 SPECTROPHOTOMETRY OF NOVA CEPHEI 1971. Bahng, J. D. R. (Northwestern Univ., Evanston, Ill.). Mon. Notic. Roy. Astron. Soc.; 158: No. 2, 151-8(Jul 1972).

Photoelectric scanner measurements were made on Nova Cephei 1971 on eight nights from July 29 to November 1, 1971. From the light curve M_v at maximum was estimated to be −8, resulting in a corrected distance of 4 to 5 kpc. The spectra of the nova show two stages of its evolution: the "4640" and the "nebular" stages. The emission measures in flux unit (erg $cm^{-2}\ s^{-1}$) were derived for strong features. The Balmer decrement was found to deviate from the theoretical value. The deviation is in the same sense as found in emission nebulae and in planetary nebulae. From the measurements of [O III] lines, $T_e = 8500°K$ was derived for the nova shell, if $N_e \geq 10^8$ is assumed. (auth)

48606 APPLICATION OF MICHELSON INTERFEROMETERS TO HIGH RESOLUTION ASTRONOMICAL SPECTROMETRY. Ring, J.; Stephens, C. L. (Imperial Coll. of Science and Tech., London). Mon. Notic. Roy. Astron. Soc.; 158: No. 2, 5P-9P (Jul 1972).

Previous work showed that the instrumental profiles of existing high-resolution spectrographs are such as to introduce errors in the measurement of absorption-line parameters. It is shown that a Michelson interferometer is theoretically much better suited to the observation of stellar line profiles at high resolution. (auth)

48607 β PERSEI. RADIO STAR AND PROBABLE X-RAY STAR. Hjellming, R. M. (National Radio Astronomy Observatory, Green Bank, W. Va.). Nature (London) Phys. Sci.; 238: No. 82, 52-5(24 Jul 1972).

β Persei is a radio star that recently has shown progressively stronger and more frequent radio flaring, and it is considered that the simplest interpretation of virtually all of β Persei data is in terms of a variable thermal bremsstrahlung source, with such high temperatures during peak levels of recent flaring that it must have become a variable x-ray star. (UK)

48608 OCCULATION OF BETA SCORPII BY JUPITER ON MAY 13, 1971. Bhattacharyya, J. C. (Indian Inst. of Astrophysics, Kodaikanal). Nature (London) Phys. Sci.; 238: No. 82, 55-6(24 Jul 1972).

Details are given of photoelectric observations of the occulation of β Scorpii by Jupiter carried out at the field station at Kavalur on the night of May 13–14, 1971, using the cassegrain focus of the 38-cm reflecting telescope. (UK)

48609 FERROMAGNETISM IN WHITE DWARFS. Pohl, H.; Schmid-Burgk, J. (Univ., Heidelberg). Nature (London) Phys. Sci.; 238: No. 82, 56-7(24 Jul 1972).

The discovery of magnetic fields of up to $\simeq 10^7$ G in two white dwarfs has stimulated interest in the magnetic properties of high-density matter. Discussion has centered largely around the theory of Landau Orbital Ferromagnetism (LOFER), which states that a gas of free electrons can, through its magnetic moment, self-consistently maintain a magnetic field β, of order 10^7 to 10^8 G at typical white dwarf densities, even after dissipation has extinguished any external sources (charge drifts) of the magnetic field. Recent investigations into this theory have concentrated on the question of stability of the discrete set of LOFER states. It is argued that although the ground state corresponds to B = O, some objects may exist in excited, nonzero B, states because these are metastable, and only detailed knowledge of the history of the sample can decide whether or not the final configuration will be magnetic. This argument makes credible the fact that some, although not all, white dwarfs appear to have large magnetic fields. It is pointed out, however, that a gas of noninteracting electrons must fulfill very stringent temperature requirements for LOFER to operate, and that these requirements appear to invalidate the foregoing arguments. It is concluded that statistically the appearance of a LOFER white dwarf is unlikely, unless it can be shown that white dwarfs cool down to $\simeq$100°K within the age of the Galaxy, and it seems that a correlation between the magnetic fields observed in some white dwarfs and LOFER theory cannot be established. Possible modifications to the original LOFER model are discussed. (UK)

48610 PHOTOELECTRIC OBSERVATIONS OF Y CYGNI (1959–1961). Herczeg, T. (Hambruger Sternwarte, Hamburg). Astron. Astrophys.; 20: No. 2, 201-4(1 Sep 1972).

A set of 184 photoelectric observations of Y Cygni is presented, obtained in 1959–1961; the measurements define 4 epochs of minimum. An ensuing short discussion of the period changes indicates that Dugan's formula still represents the apsidal rotation very well and that, further, no light–time effect of any significant amplitude can be found. Contrary to previous suggestions based on radial velocity data, the existence of a third body in the system seems rather improbable. (auth)

48611 DYNAMICAL EFFECTS OF STELLAR MASS LOSS ON DIFFUSE NEBULAE. Dyson, J. E. (Univ. of Manchester, Eng.); de Vries, J. Astron. Astrophys.; 20: No. 2, 223-32 (1 Sep 1972).

The dynamical effect of mass loss from an early-type star on a diffuse nebula is examined using a similarity method. The maintenance of velocities greatly in excess of sound speed in the nebular gas for periods $\gtrsim 10^4$ years requires very high mass-loss rates. It is, therefore, very unlikely that the high velocities measured in diffuse nebulae by Sheglov (1968) and Meaburn (1970, 1971) can be attributed to the operation of this mechanism. (auth)

48612 MODEL ATMOSPHERE ANALYSIS OF THE A3Ia–O SUPERGIANT HD 33579 IN THE LARGE MAGELLANIC CLOUD. Wolf, B. (Univ., Munich). Astron. Astrophys.; 20: No. 2, 275-85(1 Sep 1972).

A fine analysis of HD 33579, an A3Ia–O supergiant in the Large Magellanic Cloud, was done by evaluating 4 high-dispersion spectra (12.3 Å/mm) taken at the European Southern Observatory. The observations were best fitted by a model atmosphere (radiative equilibrium, LTE, no line blanketing) with the parameters T_e = 8130° and log g = 0.7 and a microturbulence varying with the optical depth from 6 km/s at $\bar{\tau} = 2.0$ to 26 km/s in the outermost layers. The computed continuum agrees reasonably with photoelectric measurements. The computed and observed color indices (corrected for interstellar absorption) were $(U-B)_{cal} = -0.29$, $(U-B)_{obs} = -0.28$, $(B-V)_{cal} = +0.13$, $(B-V)_{obs} = +0.14$. The bolometric correction was B.C. = 0.06. The profiles of the absorption lines were asymmetric, which can be interpreted by a depth dependent radial large scale motion. A strong H_α-emission can be explained by a chromospheric shell, which is moving with a velocity up to 170 km/s relative to the photosphere. The average metal abundance was practically the same as for the Sun ($\log \bar{\epsilon} - \log \bar{\epsilon}_\odot \approx +0.12$). The luminosity was computed as $L/L_\odot \approx 530000$, the radius as $R/R_\odot \approx 360$, and the mass as $M/M_\odot \approx 25$. (auth)

48613 MODEL ATMOSPHERES OF WHITE DWARFS WITH CONVECTION. Grenfell, T. C. (Univ. of Washington, Seattle). Astron. Astrophys.; 20: No. 2, 293-7(1 Sep 1972).

The Feautrier method with full linearization and variable Eddington factors was employed to construct model atmospheres of white dwarfs including, simultaneously, energy transport by radiation and convection. The procedure converges rapidly giving flux constancy to high precision. Models were computed for van Maanen 2 and Ross 640 in order to test the procedure against calculations made by Wegner. Agreement was found to be quite good for the emergent flux and temperature stratification although the layers where convection sets in differ for the two methods. The latter effect is due to the greater degree of flux constancy achieved with the present technique. (auth)

48614 BROADENING AND SHIFT OF MAGNESIUM LINES BY VAN DER WAALS INTERACTION WITH ARGON ATOMS AND BY MICROFIELDS. Helbig, V.; Kusch, H. J. (Univ., Kiel). Astron. Astrophys.; 20: No. 2, 299-304(1 Sep 1972).

Line broadening and shift of 3 neutral and 3 ionic lines of magnesium were investigated using a gas-stabilized high-pressure arc running in an argon atmosphere between a carbon cathode and a magnesium anode. From the total line profiles the broadening parameters for van der Waals interaction and for electron impact were obtained by a separation method taking into account the different behavior in temperature and pressure of these two effects. The results were compared with theoretical values obtained from the Lindholm–Foley theory and from quantum-mechanical electron impact calculations. (auth)

48615 ANGULAR MOMENTUM AND ENERGY LOSS OF A COMPACT STAR ROTATING IN A THERMAL PLASMA. Cohen, R. H.; Treves, A. (Massachusetts Inst. of Tech., Cambridge). Astron. Astrophys.; 20: No. 2, 305-8(1 Sep 1972).

Models of thermal x-ray sources in which the energy is produced by the rotation of a compact star are considered. The angular momentum loss is assumed to be caused by a Poynting–Robertson torque. The dependence of the radius of the region of emission on the velocity field of the plasma surrounding the star is examined. It is shown that in the absence of stellar winds this radius must be greater than or equal to the radius of the speed-of-light cylinder. (auth)

48616 IDENTIFICATION OF IRC-OBJECTS. Schultz, G. V. (Max-Planck-Institut fuer Radioastronomie, Bonn); Wiemer, W. Astron. Astrophys.; 20: No. 2, 317-19(1 Sep 1972).

Six early-type stars selected from the Caltech Infrared Catalog were identified as late-type stars by infrared photometry and spectroscopy. (auth)

48617 MODEL FOR THE CHEMICAL EVOLUTION OF S AND N STAR ENVELOPES. Ulrich, Roger K.; Scalo, John M. (Univ. of California, Los Angeles). Astrophys. J.; 176: No. 1, L37-42(15 Aug 1972).

A model is presented for mixing in stars during the maximum convective phase of a nondegenerate He shell flash. This model required stars of about 5 $M_\odot$ and can produce surface enrichments of ^{7}Li, ^{12}C, ^{13}C, and s-process elements. (auth)

48618 HIGH-FREQUENCY STELLAR OSCILLATIONS. IX. THE PECULIAR BLUE VARIABLE, BD–7^{0}3007. Hesser, James E.; Lasker, Barrrrry M.; Osmer, Patrick S. (Observatorio Interamericano de Cerro Tololo, La Serena, Chile). Astrophys. J.; 176: No. 1 L31-6(15 Aug 1972).

The peculiar star BD – 7°3007 varies rapidly with amplitudes less than 0.10 mag. The power spectra show no harmonic features; however, significant low-amplitude transient activity exists in the 100 to 1000 s range; and there are persistent broad-banded peaks at about 21 and 10.3 minutes. Scanner observations, showing Hα emission, broad, weak Hγ absorption, and an approximately blackbody continuum with $T_e \approx 10^4$°K, imply that the star is degenerate and deficient in hydrogen. The available data admit the presence of two degenerate stars with circumstellar material. (auth)

48619 UNUSUAL HOT STAR BD–7^{0}3007. Cowley, A. P.; MacConnell, D. J. (Univ. of Michigan, Ann Arbor). Astrophys. J.; 176: No. 1, L27-30(15 Aug 1972).

The almost continuous spectrum of BD − 7°3007 is shown to have very broad hydrogen lines with weak and variable central emission. In addition, both Ca II and He I are definitely present. Photometry shows the star to lie near the blackbody curve with a temperature of about 14,000°K. The spectroscopic and photometric properties are compared with white dwarfs, old novae, and other subluminous objects. (auth)

48620 TRANSURANIUM ELEMENTS IN HD 25354. Jaschek, M.; Brandi, E. (Observatorio Astronomico, La Plata). Astron. Astrophys.; 20: No. 2, 233-5(1 Sep 1972).

Arguments are presented for the presence of U, Th, and W in the Ap star HD 25354. Evidence is also shown for the presence of some transuranium elements, like Am and Cm. The presence of several elements not usually found in Ap stars, with Z about 40, might lend support to the occurrence of nuclear fission in this star. (auth)

48621 SLOWLY ROTATING RELATIVISTIC STARS. VI. STABILITY OF THE QUASI-RADIAL MODES. Hartle, James B. (Univ. of California, Sant Barbara); Thorne, Kip. S.; Chitre, S. M. Astrophys. J.; 176: No. 1, 177-94(15 Aug 1972).

Equations are given for calculating the effects of a slow and rigid rotation on the frequency of the radial modes of oscillation of a relativistic star. The rotation is treated to second order in the angular velocity, but no other approximations are made. (auth)

48622 BOWEN FLUORESCENCE MECHANISM IN PLANETARY NEBULAE. Harrington, J. Patrick (Univ. of Maryland, Richmond). Astrophys. J.; 176: No. 1, 127-37(15 Aug 1972).

Solutions were obtained for the transfer of He II Lα radiation in model planetary nebulae. Absorption of the Lα photons in both the $2p^2\,{}^3P_2 - 2p3d\,{}^3P^0_2$ (303.799 Å) and $2p^2\,{}^3P_2 - 2p3d\,{}^3P^0_1$ (303.693 Å) lines of O III were considered. The efficiency of the Bowen mechanism was found to be about 50%, in agreement with earlier investigations. The fraction of the Lα photons destroyed by cascades from the $2p3d\,{}^3P^0_1$ level depends upon the Doppler temperature, varying from 1.6% at 11,000°K to 2.6% at 18,000°K. Measurement of the intensities of the weak lines from this level permits an important test of the radiative-transfer theory in the far wing of the Lα line. The available observations are reviewed and are shown to be in good agreement with the predictions of theory. (auth)

48623 NON-LTE EFFECTS ON CONTINUUM AND HYDROGEN-LINE PARAMETERS IN B AND O STARS. Mihalas, Dimitri (National Center for Atmospheric Research, Boulder). Astrophys. J.; 176: No. 1, 139-52(15 Aug 1972).

Using a homogeneous set of non-LTE models (which allow for bound–bound transitions) on the range $15{,}000° \leq T_{eff} \leq 55{,}000°K$ at several gravities, the effects of departures from LTE upon the continuum and Balmer lines are evaluated. Several observational discriminants of non-LTE effects are discussed; in certain specific examples considered, the available data are well fitted by the non-LTE calculations. (auth)

48624 OBSERVATIONS OF THE STELLAR Mg II RESONANCE DOUBLET AT 2795 AND 2802 A. Kondo, Yoji (NASA Manned Spacecraft Center, Houston); Giuli, R. Thomas; Modisette, Jerry L.;Rydgren, A. E. Astrophys. J.; 176: No. 1, 153-64 (15 Aug 1972).

Spectrophotometry of the Mg II resonance doublet at 2795.5 and 2802.7 Å was performed for five stars with a balloon-borne telescope and spectrometer. Spectral resolution attained was between 0.25 and 0.5 Å. A description of the payload and flight operations is given. The stars observed were β Lyr, γ Lyr, β Cas, α CMi, and α Ori. In β Lyr the Mg II doublet displayed P Cygni characteristics, while in γ Lyr the doublet was observed only in absorption. The star β Cas showed broad overlapping Mg II absorption lines with possible weak emission at the line bottom. In α CMi, both components of the doublet were seen in emission at the bottom of the broad absorption feature. The Mg II doublet in α Ori was entirely in emission, with each component showing distinct self-reversal. Comparison was made between Ca II and Mg II emission widths for stars of spectral type F and later. The widths of the Mg II emission lines measured in km s^{-1} were between two and three times greater than the widths of Ca II emission lines in the same star. (auth)

48625 MASS OF TU CASSIOPEIAE. Schmidt, Edward G. (Univ. of Arizona, Tucson). Astrophys. J.; 176: No. 1, 165-8(15 Aug 1972).

By use of a measured temperature and the value of Q_0 implied by the period ratio, the mass of the beat Cepheid, TU Cas, was determined. The value found (4.0 $M_\odot$) compares well with values for evolutionary models (4.0 to 4.7 $M_\odot$). On the other hand, the mass calculated from pulsation theory using the period, luminosity, and temperature was smaller than either of these two estimates ($M_Q = 3.3\ M_\odot$). This would indicate either that the interpretation of the beat phenomenon in terms of the period ratio is incorrect or that the model calculations of periods and period ratios are in error. (auth)

48626 CNO ABUNDANCES AND HYDRODYNAMIC MODELS OF THE NOVA OUTBURST. Starrfield, Sumner (IBM Thomas J. Watson Research Center, Yorktown Heights, N. Y.); Truran, J. W.; Sparks, Warren M.; Kutter, G. S. Astrophys. J.; 176: No. 1, 169-76(15 Aug 1972).

A fully implicit, Lagrangian, hydrodynamic computer code incorporating a nuclear reaction network was used to follow thermonuclear runaways in the hydrogen-rich envelopes of white dwarfs in order to produce a nova outburst. Because of the short timescales and the high nuclear burning rates produced in the models ($T > 3 \times 10^8$°K and $\epsilon_{nuc} > 10^{18}$ ergs $g^{-1}\ s^{-1}$) the nuclear reactions are far out of equilibrium and the β^+-unstable nuclei become the most abundant nuclei in the envelope except for hydrogen and helium. The models have ejected $1.7 \times 10^{-4}\ M_\odot$ with kinetic energies of 8×10^{44} ergs a value that agrees quite closely with the observed values for novae. The initial abundance of the CNO nuclei was varied, and it was found that the actual ejection of material and production of an outburst requires these nuclei to be strongly enhanced and that observed features of the outburst depend on the degree of CNO enhancement. The final isotopic abundances in the ejected material do not correspond to equilibrium CNO burning and are a strong test of the model for the outburst. (auth)

48627 MODELS OF DIFFERENTIALLY ROTATING STARS. Wilson, James R. (Univ. of Calif., Livermore). Astrophys. J.; 176: No. 1, 195-204(15 Aug 1972).

The binding energy is calculated for rotating stars, with pressure equal to one-third the thermal energy density, by means of general relativity. For large central redshifts, the binding energy decreases rapidly as one proceeds from flat disk shapes to more nearly spherical stars. Binding-energy curves are also presented for the case of pressure equal to the thermal energy. (auth)

48628 ENERGY SHIFTS OF EXCITED NUCLEONS IN NEUTRON-STAR MATTER. Sawyer, Raymond F. (Univ. of Calif., Santa Barbara). Astrophys. J.; 176: No. 1, 205-11 (15 Aug 1972).

It is argued that baryon isobars embedded in superdense neutron-star matter will suffer large positive energy shifts, even in the absence of ordinary two-body interactions of the isobars with the other baryons of the matter. These shifts arise from the isobars being denied the virtual states consisting of already filled baryon states plus pions. A numerical calculation is done for a zero-momentum Δ^- (1236 MeV) immersed in a pure neutron medium, and energy shifts of from 145 to 250 MeV are found for the range of neutron densities which had been expected to prevail at the onset of the formation of Δ^-'s in superdense nuclear matter. In view of these energy shifts the Δ^-'s are now predicted not to appear in the ground state of matter up to densities of 10^{16} g cm^{-3}. Doubt is cast on the use of statistical baryon level density formulae to calculate equations of state for cold matter at even higher baryon densities. (auth)

Quasi-Stellar, Radio, and X-Ray Sources

Refer also to abstracts 48615, 48732, and 49170.

48629 (N–72–20792) OBSERVATION OF PULSED GAMMA RAYS WITH ENERGIES GREATER THAN 250 keV FROM THE CRAB NEBULA PULSAR NP 0532. Orwig, Larry E. (New Hampshire Univ., Durham. Dept. of Physics). Dec 1971. 229p. (NASA-CR–125820; UNH–7203). NTIS.

Data from a balloon-flight experiment using an NaI scintillation spectrometer were analyzed for gamma-ray pulsation. The payload was carried to a nominal atmospheric depth of 3.5 g/cm^2. A superposed epoch analysis was performed on a 12,000 second portion of the data spanning a total time interval of 16,700 seconds at float altitude. A positive pulsed contribution was observed at the expected apparent frequency of NP 0532 having the typical double-pulse structure. The results indicate a time-averaged pulse photon flux of 0.00144 ± 0.00057 photons/ sq cm/sec in the energy interval from 250 keV to 2.3 MeV. This represents a time-averaged pulsed power of 0.000649 ± 0.000257 keV/sq cm/sec/keV. The ratio of interpulse to main pulse was found to be 2.4 ± 1.9. The analysis indicates a positive photon flux from 250 keV to 725 keV of 0.00120 ± 0.00052 photons/sq cm/sec. (auth) (STAR)

48630 SEARCH FOR HIGH-ENERGY POINT SOURCES OF γ QUANTA. Stepanyan, A. A.; Vladimirskii, B. M.; Pavlov, I. V.;

Fomin, V. P. Izv. Akad. Nauk SSSR, Ser. Fiz.; 35: No. 12, 2458-62(Dec 1971). (In Russian).

Refinements were introduced into equipment for counting Cherenkov bursts of extensive air showers. Methods of fabricating the equipment are detailed. The upper limits of the γ-quanta flux received from pulsars CP 0328 and CP 2218 and the radio galaxy 3C 66 were, respectively, 6×10^{-12}, 3×10^{-12}, and 3×10^{-11} $cm^{-2} \cdot sec^{-1}$. For pulsar CP 1133 the 1970 observation did not reveal as sharp an effect as did that of 1969. (tr-auth)

48631 OBSERVATION OF γ QUANTA WITH ENERGIES GREATER THAN 100 MeV FROM THE VICINITY OF THE CRAB NEBULA. Volobuev, S. A.; Gal'per, A. M.; Kirillov-Ugryumov, V. G.; Luchkov, B. I.; Ozerov, Yu. V. Izv. Akad. Nauk SSSR, Ser. Fiz.; 35: No. 12, 2463-5(Dec 1971). (In Russian).

The artificial Earth satellites Kosmos-251, 264, and 280 carried equipment that recorded γ quanta with energies $\gtrsim$ 100 MeV. On one flight the equipment scanned the portion of the sky where the Crab Nebula is located. The data are manipulated accordingly, allowing for the tilt of the satellite axis, its period of revolution, and number of orbits. (K.S.W.)

48632 RELATIONS BETWEEN COSMIC AND LABORATORY PLASMA PHYSICS. Alfven, Hannes (Royal Inst. of Tech., Stockholm). pp 1-14 of Cosmic Plasma Physics. /Schindler, Karl (ed.). New York, Plenum Publishing Corp. (1972).

From Conference on cosmic plasma physics; Frascati, Italy (20 Sep 1971). See CONF-710951.

A review is given of the development of plasma physics. Experimental and theoretical approaches are discussed. Some general remarks are made about the present state of astrophysics. (M.O.W.)

48633 PLASMA TURBULENT HEATING AND THERMAL X-RAY SOURCES. Coppi, B.; Treves, A. (Massachusetts Inst. of Tech., Cambridge). pp 215-23 of Cosmic Plasma Physics. /Schindler, Karl (ed.). New York, Plenum Publishing Corp. (1972).

From Conference on cosmic plasma physics; Frascati, Italy (20 Sep 1971). See CONF-710951.

A class of thermal x-ray sources is associated with rotating collapsed stars surrounded by an extended plasma shell. Scorpio X-1 is considered a characteristic example of this type of stars and the heating mechanism of its plasma-sphere is discussed in detail. (auth)

48634 RADIO AND OPTICAL OBSERVATIONS OF PULSARS. Drake, F. D. (Cornell Univ., Ithaca, N. Y.). pp 225-31 of Cosmic Plasma Physics. /Schindler, Karl (ed.). New York, Plenum Publishing Corp. (1972).

From Conference on cosmic plasma physics; Frascati, Italy (20 Sep 1971). See CONF-710951.

Distribution of pulsar periods and pulse shapes of NP 0532 at different frequencies are shown along with pulse shapes of nine other pulsars. The marching subpulses phenomenon and definition of different periodicities are illustrated. (W.D.M.)

48635 PROPAGATION OF RELATIVISTIC ELECTROMAGNETIC WAVES IN A PLASMA. Perkins, F. W.; Max, C. E. (Princeton Univ., N. J.). pp 233-8 of Cosmic Plasma Physics. /Schindler, Karl (ed.). New York, Plenum Publishing Corp. (1972).

From Conference on cosmic plasma physics; Frascati, Italy (20 Sep 1971). See CONF-710951.

Pulsars are capable of producing relativistic electromagnetic waves [those with $(eE/m_{\epsilon}\omega c) \gg 1$] over large regions of space. This paper is devoted to a study of how the presence of a plasma affects the propagation of these waves and how the waves influence the plasma. An analytic solution to the nonlinear equations governing the propagation of a relativistic linearly polarized wave will be presented. With this solution as starting point, the conditions under which the wave will produce instabilities in the plasma are discussed along with the consequences of these instabilities. (auth)

48636 THREE-DIMENSIONAL RELATIVISTIC COMPUTATION FOR THE PULSAR MAGNETOSPHERE. Kuo-Petravic, G. (Oxford Univ.); Petravic, M.; Roberts, K. V. pp 239-47 of Cosmic Plasma Physics. /Schindler, Karl (ed.). New York, Plenum Publishing Corp. (1972).

From Conference on cosmic plasma physics; Frascati, Italy (20 Sep 1971). See CONF-710951.

The problem of the generation of radio frequency bursts from pulsating stars has attracted much attention ever since the discovery of the first pulsar in 1968. Most of the current theories for pulse generation assume that the energy is supplied by a rotating neutron star possessing a magnetic (dipole) field which rotates with it and which transforms the rotational energy into low frequency (~HZ) electromagnetic radiation and kinetic energy of the plasma surrounding the star. The plasma energy is then in some way converted into radiation energy at the radio and higher frequencies. This paper is concerned with the detailed study of the dynamics of the rotating magnetic field—plasma interaction in the actual 3-D geometry of the pulsar. The approach is computational and uses novel techniques with automatic programming of the appropriate vector partial differential equations. First of all, Maxwell's equations are solved using the leapfrog finite-difference method on a three-dimensional spherical mesh, to obtain the vacuum solutions. Secondly, relativistic fluid equations for positively and negatively charged-particle species are introduced and solved together with Maxwell's equations, providing a self-consistent solution for the magnetic and electric fields, charge densities and currents in the vicinity of the star. Particular attention is paid to the motions and accelerations in the region of the light cylinder, where charges corotating with the magnetic field would have to reach the velocity of light. (auth)

48637 ORIGIN OF PULSAR RADIATION. Zheleznyakov, V. V. (Gorky Radiophysics Inst., USSR). pp 249-59 of Cosmic Plasma Physics. /Schindler, Karl (ed.). New York, Plenum Publishing Corp. (1972).

From Conference on cosmic plasma physics; Frascati, Italy (20 Sep 1971). See CONF-710951.

The pulsar theory involves three main questions: (1) type and constitution of the central body; (2) structure of the magnetosphere; (3) mechanisms of radio emission from pulsars. A successive solution of these problems is a desirable way to develop the theory. It is very complicated to carry out the program especially if one takes into account that the criterion of validity of the theory is at the very end of the scheme and involves the comparison of theoretical peculiarities of radiation with the observed ones. This lecture deals with the more limited problem of the choice of those conditions in the magnetosphere of the star (the position and velocity of the source, the magnetic field strength, the spectrum of charged particles, etc.) which provide generation of radiation with observed characteristics. (auth)

48638 STRONG MAGNETIC FIELD EFFECTS IN THE PULSAR CRUSTS AND ATMOSPHERES. Kalman, G. (Boston Coll. Brandeis Univ., Waltham, Mass.); Bakshi, P.; Cover, R. pp 261-8 of Cosmic Plasma Physics. /Schindler, Karl (ed.). New York, Plenum Publishing Corp. (1972).

From Conference on cosmic plasma physics; Frascati, Italy (20 Sep 1971). See CONF-710951.

The equation of state and magnetic response function of an electron gas in a strong magnetic field are derived, pertaining to the situation prevailing in pulsar crusts. The most interesting conclusion emerging from this study is the existence of various unstable situations and phase transitions appearing at certain critical values of the magnetic field and density. The first type of instability is a consequence of the dropping of d log P/d log n (P = pressure, n = density) below a certain critical value, necessary for the maintenance of overall gravitational stability of the crust. The second family of instabilities is of local character, related to magnetic phase transitions previously studied by Chiu, Canuto, Lee, and Quinn. The relation between ferromagnetic and "antiferromagnetic" transitions is discussed, in particular it is studied whether the electron gas in pulsars can indeed undergo a ferromagnetic transition. The polarizability of the combined vacuum—plasma system was also studied. A new and complete expression for the vacuum polarization in strong magnetic field was employed to study the effect of the magnetic field on the interaction between particles and the propagation of electromagnetic waves in the pulsar atmosphere. (auth)

48639 FLUX DENSITIES, POSITIONS, AND STRUCTURES FOR A COMPLETE SAMPLE OF INTENSE RADIO SOURCES AT 1400 MHz. Bridle, A. H. (Queen's Univ., Kingston, Ont.); Davis, M. M.; Fomalont, E. B.; Lequeux, Jr. Astron. J.; 77: No. 6, 405-43(Aug 1972).

Accurate flux densities, precise positions of unresolved sources, and structures of resolved sources were derived from full-beam and interferometric observations of intense sources at 1400 MHz. Results are given for 424 sources in the area of sky $-5° < \delta < +70°$, $|b| > 5°$ whose 1400-MHz integrated flux densities S_{1400} exceed 1.70 f.u. [1 flux unit (f.u.) = 10^{-26} $w.m.^{-2}$ Hz^{-1}]. The 234 sources with $S_{1400} \geq 2.00$ f.u., equivalent diameters <10 arc min, and $|b| > 20°$ form a 98 ± 2% complete sample comparable in number to the 178-MHz Revised Third Cambridge Catalogue in this 4.30-sr area of sky, but selected at 1400 MHz. This sample is suitable for statistical studies of the properties of extragalactic radio sources. To facilitate its use, and that of other samples which may be drawn from these data, references to other studies of the positions, fine and extended structure, polarization, and variability of the sources are assembled in the principal table of this paper. A comparison is made with other 1400-MHz flux-density data, and the spectral content of the complete sample is discussed. (auth)

48640 OPTICAL POSITIONS OF FORTY-EIGHT QUASISTELLAR OBJECTS. Barbieri, C.; Capaccioli, M.; Ganz, R.; Pinto, G. (Astronomical Observatory, Padua). Astron. J.; 77: No. 6, 444-7 (Aug 1972).

Optical positions are presented for 48 quasi-stellar objects. The positions were derived in comparison to AGK3 stars (or to SAO stars for fields having declination south of -2° and also for 3C 345) from Schmidt-telescope plates taken at Asiago. The scale on the plate is approximately 10 $\mu m \simeq 1''$. The results are believed to be accurate at the 0.3 to 0.4" level. (auth)

48641 OBSERVATIONS OF THE CYGNUS LOOP AT 6-cm WAVELENGTH. Kundu, M. R.; Becker, R. H. (Univ. of Maryland, College Park). Astron. J.; 77: No. 6, 459-63(Aug 1972).

Brightness and polarization distributions of the Cygnus Loop were measured at 6-cm wavelength. Strong polarization of up to 25% was observed throughout the source south of $\delta = 31^\circ 00'$. Significant polarization was detected in the northeastern shell region (NGC 6992-95). The derived magnetic-field distribution was found to be tangential to the southern boundary of the source, in agreement with previously published results. (auth)

48642 BALLOON SEARCH FOR EXTRATERRESTRIAL HIGH ENERGY γ-RAYS IN THE NORTHERN HEMISPHERE. Niel, M. (Centre d'Etude Spatiale des Rayonnements Complexe Aerospatial, Toulouse); Vedrenne, G.; Claverie, A.; Bouigue, R. Astron. Astrophys.; 20: No. 1, 1-8(Aug 1972).

The results are presented of 5 balloon flights intended for the research of possible sources of γ rays above 60 MeV in the northern hemisphere, and of a possible anisotropy of the γ-ray flux detected towards the galactic plane. These results obtained with a spark chamber γ-ray telescope enable apparent flux values from several zones to be given, but in most cases only upper limits to the γ-ray fluxes from possible γ-ray sources were evaluated. However, these flights have, in the Cygnus region, brought out a significant γ-ray flux at the 2.5 or 3.5 σ confidence level according to whether the γ-ray events are integrated into galactic latitude and longitude bands: $-6^\circ < b_{II} < +18^\circ$, $45^\circ < l_{II} < 85^\circ$ or $-6^\circ < b_{II} < +18^\circ$, $65^\circ < l_{II} < 80^\circ$. (auth)

48643 VARIABLE SPACING MODULATION COLLIMATOR FOR X-RAY ASTRONOMY. Adams, D. J.; Janes, A. F.; Whitford, C. H. (Univ. of Leicester, Eng.). Astron. Astrophys.; 20: No. 1, 121-30(Aug 1972).

A modulation collimator instrument for high spatial resolution studies in x-ray astronomy is described. The technique employed is suitable for use on a three axis stabilized vehicle, and produces an output which is a Fourier Transform of the field observed. The angular resolution of the instrument is calculated, and its sensitivity is shown to compare favorably with that of conventionally collimated instruments. The instrument can be used to locate pulsating stellar x-ray sources. (auth)

48644 POLARISATION OF SYNCHRO-COMPTON RADIATION. Blandford, R. D. (Cambridge Univ., Eng.). Astron. Astrophys.; 20: No. 1, 135-44(Aug 1972).

Calculations are presented of the spectral and polarization properties of synchro-Compton radiation. Both linear and circular polarization are discussed. The results are applicable primarily to the case of a power law distribution of relativistic electrons radiating in a monochromatic, plane, strong wave of fixed elliptical polarization. Approximations are introduced which are valid provided that (electron energy/$m_e c^2$) $\gg f^2 \gg 1$ where f is the nonlinearity parameter of Gunn and Ostriker (1971). The calculations confirm that the polarization of the emitted radiation broadly mimics the polarization of the strong wave, the circular component being scaled by a factor $-f^{-1}$. The relevance of these results to astrophysics is discussed. (auth)

48645 NATURE OF THE TYCHO X-RAY SOURCE. Shklovskii, I. S. (Inst. for Cosmic Research, Moscow). Nature (London); 238: No. 5360, 144(21 Jul 1972).

Reasons are given as to why, of the five x-rays sources identified with supernovae remnants, the Tycho 1572 source is of particular interest. The x-ray emission cannot be considered as a continuation of the synchrotron radio spectrum, and it cannot be assumed that the observed x radiation is thermal and caused by hot plasma behind the shock front produced by the expanding envelope of a remnant. It seems probable that the source should be identified with a young pulsar that originated after the explosion of the Tycho supernova. There are good reasons to believe that young pulsars should generate synchrotron radiation in the optic and x-ray ranges, the power of this radiation being a very steeply diminishing function of the pulsar's age. Some comparisons are made with data on the Crab pulsar NP 0532. Tests for the hypothesis advanced are given. It is also printed out that there is a "quasi-isotropic" component in the x radiation of young pulsars. (UK)

48646 POSITIONS AND FLUX DENSITIES AT 1415 MHz OF 5C3 SOURCES NEAR M31. Van Der Kruit, P. C.; Katgert, P. (Sterrewacht, Leiden). Astrophys. Lett.; 11: No. 4, 181-5(Aug 1972).

Observations of part of M31 and NGC 205 with the Westerbork Synthesis Radio Telescope provide positions, flux densities, and spectral indices between 408 and 1415 MHz for 30 5C3 radio sources and upper limits to flux densities and lower limits to spectral indices for 14 sources. (auth)

48647 NEW IDENTIFICATION FOR PKS2204-54. Tritton, K. P. (Royal Greenwich Observatory, Hailsham, Eng.); Nicolson, G. D. Astrophys. Lett.; 11: No. 4, 187-8(Aug 1972).

An object with an ultraviolet excess is suggested as the correct identification for PKS 2204-54, on the basis of intensity variations detected at 13 cm. The possible existence of a galaxy cluster in the field of the object is noted. (auth)

48648 OPTICAL IDENTIFICATION OF 3C220.2. Wills, D. (Univ. of Texas, Austin); Lynds, R. Astrophys. Lett.; 11: No. 4, 189-90(Aug 1972).

The object 3C 220.2, previously thought to be a galactic star, is a quasi-stellar object. (auth)

48649 SOME OBSERVATIONAL DISTINCTIONS AMONG MODELS OF PULSING X-RAY BINARIES. Arons, Jonathan; Bahcall, John N. (Inst. for Advanced Study, Princeton, N. J.). Astrophys. Lett.; 11: No. 4, 191-4(Aug 1972).

Observational distinctions between various models for the environment of pulsing x-ray binaries are described. It is pointed out that all observations available so far are consistent with x-ray binaries being systems containing only "familiar" objects, i.e., a rotating neutron star and a massive normal star such as an A or B supergiant. (auth)

48650 FORMALDEHYDE ABSORPTION IN THE SOUTHERN COAL SACK. Sinclair, M. W.; Brooks, J. W. (CSIRO, Sydney). Astrophys. Lett.; 11: No. 4, 207-10(Aug 1972).

Absorption of the 2.7 K background by the $1_{11} \rightarrow 1_{10}$ transition of formaldehyde has been observed in the southern Coal Sack with an antenna beam of 4.4 arc min and a frequency resolution of 10 kHz. The absorbing region appears to be confined to a small dense cloud of diameter 0.3 pc and having a minimum optical depth of 0.17. The radial velocity of the absorbing cloud as given by the absorption profile is -6.5 km sec^{-1}, corresponding to a kinematic distance of 170 pc to the cloud, in agreement with optical estimates. (auth)

48651 SPATIAL COINCIDENCES OF X-RAY SOURCES AND SUPERNOVA REMNANTS. Cowley, A. P.; Macconnell, D. J. (Univ. of Michigan, Ann Arbor). Astrophys. Lett.; 11: No. 4, 217-18(Aug 1972).

The x-ray source 2U 1509-58 may be identified with the radio supernova remnant Milne 33 (= Downes 38 = Kesteven 23) as well as with an Hα nebulosity RCW 89. The proximity of six ancient novae or supernovae to x-ray sources in the Uhuru Catalogue is pointed out. (auth)

48652 POSSIBLE SITES OF STAR FORMATION IN Sgr B2. Martin, A. H. M. (Cavendish Lab., Cambridge, Eng.); Downes, D. Astrophys. Lett.; 11: No. 4, 219-24(Aug 1972).

Observations of Sgr B2 with the Cambridge One-Mile Telescope at 2.7 and 5 GHz reveal seven bright condensations of angular size $\lesssim$10 arc sec immersed in an extended background of diameter 4 arc min. Each compact condensation requires for its excitation one to three O5 stars within a zone one light year across. These emission zones are discussed in the context of a six-component physical model for Sgr B2. Conditions in Sgr B2 are more favorable to star formation than in any other galactic source, and the compact radio components may thus indicate the presence of newly-formed O stars near the nucleus of the Galaxy. (auth)

48653 ACCURATE FLUX DENSITIES AT 5009 MHz OF 1007 RADIO SOURCES. Shimmins, A. J.; Bolton, J. G. (CSIRO, Epping, New South Wales). Aust. J. Phys., Astrophys. Suppl.; No. 23, 1-41(Jun 1972).

Accurate flux densities at 5009 MHz for 1007 radio sources are presented together with the measured positions at this frequency. The sources were selected between declinations $+27^\circ$ and -90°

from the Parkes 408 and 2700 MHz catalogues, but are predominantly south of declination −33°. The accuracy of the peak flux density is 0.02 f.u. (r.m.s.) due to system noise and confusion plus 3.0% of the flux density due to uncertainty in receiver sensitivity and dish efficiency. Because of the small beamwidth of 4.05′ arc, some of the sources are partly resolved, and size correction factors were calculated from either known source structure or measured beamwidths. The estimated errors in the positions are approximately 15″ arc in both coordinates for sources stronger than 1 f.u., increasing to 20″ arc for the weaker sources. (auth)

48654 FLOATING ORBITS, SUPERRADIANT SCATTERING, AND THE BLACK-HOLE BOMB. Press, W. H.; Teukolsky, S. A. (California Inst. of Tech., Pasadena). Nature (London); 238: No. 5361, 211-12(28 Jul 1972).

It has been shown that, in principle, rotational energy can be extracted from a black hole by orbiting and fissioning particles, and also that waves can extract rotational energy— due to "superradiant scattering," in which an impinging wave is amplified as it scatters off a rotating hole. In this connection the possible existence of "floating orbits" has been suggested, that is, orbits in which a particle radiatively extracts energy from the hole at the same rate as it radiates energy to infinity, and thereby experiences zero net radiation reaction. The present authors point out an application of "superradiant scattering" referred to as the "black-hole bomb," constructional features of which are described. They also give the chief results of quantitative analyses of "superradiant scattering," floating orbits, and the "black-hole bomb," for the case of scalar waves. The scalar results suggest that gravitational floating is not implausible, and might conceivably enter into the dynamics of material processes near rotating black holes. (UK)

48655 RIGIDITY OF A BLACK HOLE. Carter, B. (Cambridge Univ., Eng.). Nature (London) Phys. Sci.; 238: No. 83, 71-2(31 Jul 1972).

A discussion is presented on the analogy between a "black hole" and an ordinarily rigidly rotating body. (UK)

48656 ACCURATE POSITION OF PSR 1749-28 FROM LUNAR OCCULTATIONS. Rao, A. P.; Krishnamohan, S. (Tata Inst. of Fundamental Research, Bombay). Nature (London) Phys. Sci.; 238: No. 83, 69-70(31 Jul 1972).

An accurate radio position of the pulsar PSR 1749-28 was derived from lunar occultations observed at Ooty in India. The observations provided an independent check on the position obtained from times of arrival measurements and considerably improved the positional accuracy. The occultations were recorded at 327 MHz with the Ooty radio telescope in November 1970 and January and March 1971. (UK)

48657 SELECTION EFFECTS IN SPECTROSCOPIC OBSERVATIONS OF QSOs. Wills, D. (Univ. of Texas, Austin). Nature (London) Phys. Sci.; 238: No. 83, 70-1(31 Jul 1972).

It has been suggested that the observed redshift distribution among QSOs is largely determined by observational selection effects and therefore should not be used in studies of possible cosmological models or of the properties of QSOs. The present author considers that the importance of these effects has been overstated and that, with some exceptions and reservations, the observed distribution is a useful approximation to the true distribution. (UK)

48658 GX 340 +0 AS A HOT NEUTRON STAR. Greenstein, G. (Amherst Coll., Mass.). Nature (London) Phys. Sci.; 238: No. 83, 71(31 Jul 1972).

It has been shown that the x-ray spectrum of GX 340 + 0 is consistent, in the range 1 to 10 keV, with that of a black body of radius 8 ± 4 km at a temperature $\simeq 1.5 \times 10^7$°K. This source also shows many of the expected properties associated with thermal radiation from a relatively massive neutron star. The cooling time for such a star has been quoted to be at most a few years (Tsuruta and Cameron, Canadian J. Phys., 44: 1863(1966)), forcing the postulation of a somewhat "strained" accretion process to understand such a high temperature. The present author states that, in the light of recent theoretical developments, the cooling calculations of Tsuruta and Cameron are in need of extensive revision, and that such accretion processes need not necessarily be invoked; attention is concentrated on temperature estimates based on the theory of frictional heating of superfluid magnetized neutron stars. It is concluded that at present there is no reason not to regard GX 340 + 0 as a hot neutron star on the order of centuries old. (UK)

48659 PULSARS AND PAIR PRODUCTION IN ELECTRIC FIELDS. Parker, L. (Univ. of Wisconsin, Milwaukee); Tiomno, J. Nature (London) Phys. Sci.; 238: No. 82, 57-8(24 Jul 1972).

Some coincidences of observed pulsar properties with those of a radially oscillating coherent plasma of electron–positron pairs produced by a sufficiently strong electric field around a central object are discussed. It is concluded that although it seems unlikely that such a model describes real pulsars, it is nevertheless interesting, and may possibly find application elsewhere. (UK)

48660 INTERACTION OF SCO X-1 WITH ITS ENVIRONMENT. Silk, J.; Goldsmith, D. W.; Field, G. B.; Carrasco, L. (Univ. of California, Berkeley). Astron. Astrophys.; 20: No. 2, 287-91(1 Sep 1972).

X-ray emission from Sco X-1 may be a significant source of ionization for the surrounding interstellar gas, and can enable one to interpret, in particular, the possible recent detection by Johnson (1971) of enhanced Hβ emission in the vicinity of Sco X-1. A constant temperature was assumed in the medium surrounding Sco X-1 and simple analytic and numerical solutions for the variation in electron density and emission measure with distance from the x-ray source were calculated. The Hβ observations set limits on the parameters of a possible variable soft component of Sco X-1 which has been suggested by recent low energy x-ray observations. (auth)

48661 CYGNUS X-REGION. VII. RADIO CONTINUUM SEARCH FOR A RING OF FILAMENTS AROUND THE AREA. Kap-herr, A. v.; Wendker, H. J. (Max-Planck-Institut fuer Radioastronomie, Bonn). Astron. Astrophys.; 20: No. 2, 313-15(1 Sep 1972).

A ring of optically visible filaments around the Cygnus X-region was searched for radio continuum radiation at 1420 MHz. The optical filaments could possibly belong to a fossil Strömgren sphere. Although several of the filaments were detected, the search for the ring as a whole was negative. It is suggested that the ring does not exist. One of the radio sources coincides with a very thin, but very bright filament which looks like a shock front seen edge on. It is also difficult to see why all the filaments should belong to a fossil Strömgren sphere. Some of them are shown to be situated on the nearby side of the Cygnus Rift, which is assumed to be in front of the fossil Strömgren sphere. (auth)

48662 BRIGHTNESS AND POLARIZATION STRUCTURE OF FOUR SUPERNOVA REMNANTS 3C58, IC443, W28, AND W44 AT 2.8 CENTIMETER WAVELENGTH. Kundu, M. R.; Velusamy, T. (Univ. of Maryland, College Park). Astron. Astrophys.; 20: No. 2, 237-44(1 Sep 1972).

Distributions of brightness and polarization over four supernova remnants 3C58, IC443, W28, and W44 were measured at 2.8-cm wavelength with a beam of 3′. Distributions of rotation measure over these sources were computed by comparing the present data with the data at longer wavelengths. Significantly large variations of rotation measure over all the four sources were observed. The rotation measure varied systematically over the sources 3C58 and W44. Possible origin of the Faraday rotation entirely in the interstellar medium outside the remnants is discussed. The distributions of the orientation of the projected magnetic field, derived from the data, indicated very uniform orientation for the magnetic fields over both 3C58 and W44. There was no evidence for radial magnetic fields in IC443. In W28, the projected magnetic field is tangential to the northern shell part of the remnant. The physical parameter for the remnants resulting from this study is given (auth)

48663 RADIO SEARCH FOR THE PULSING X-RAY SOURCE IN HERCULES. Doxsey, R.; Murthy, G. T.; Rappaport, S.; Spencer, J.; Zaumen, W. (Massachusetts Inst. of Tech., Cambridge). Astrophys. J.; 176: No. 1, L15-18(15 Aug 1972).

The region of the celestial sphere near the pulsing x-ray source in Hercules (2U 1705 + 34) was searched for radio emission with the NRAO three-element interferometer. The search was conducted during a period when the Hercules source was in its 27-day state of low x-ray luminosity. Four weak radio sources, which may be considered as candidates for the radio counterpart of this x-ray source, were detected. (auth)

48664 MASS LIMIT OF CENTAURUS X-3. Weedman, D. W.; Hall, D. S. (Vanderbilt Univ., Nashville). Astrophys. J.; 176: No. 1, L19-21(15 Aug 1972).

It is possible to construct a model in which the x-ray source in Cen X-3 has a mass of 1 $M_\odot$. Wilson arrived at a very much smaller limit by forbidding the larger component to exceed the Roche limit. But it is possible that the observed radius of the large component is appreciably larger than its Roche lobe, for instance if it has a thick expanding atmosphere. Calculations, based on a mass of 1 $M_\odot$ for the x-ray source and relative radius of 0.74 for the larger component, show that the mass which must be lost for the larger component should flow toward the x-ray source. (auth)

48665 ATTEMPT TO DETECT THE 3-CENTIMETER FINE-STRUCTURE TRANSITION OF HYDROGEN IN H II REGIONS. Myers, P. C.; Barrett, A. H. (Massachusetts Inst. of Tech., Cambridge). Astrophys. J.; 176: No. 1, 111-26(15 Aug 1972).

A search for the 2 $^2P_{3/2}$–2 $^2S_{1/2}$ transition of hydrogen at 9.9 GHz failed to detect this spectral line in six galactic H II regions: W3, W10, W49, W51, DR21, and Sgr B2. The detection limit was 0.1°K, or $4\Delta T_{rms}$. Expressions for line brightness temperature are derived from a model H II region of uniform density, which emits and absorbs both line and continuum radiation. Upper limits on the integrated 2 $^2P_{3/2}$ density and on the ground-state density are derived from this model and from the results of the observations. Estimates are made of the likelihood of detecting two other microwave lines of hydrogen in H II regions: 3 $^2P_{3/2}$–3 $^2S_{1/2}$ at 2.94 GHz, and 2 $^2S_{1/2}$–2 $^2P_{1/2}$ at 1.06 GHz. (auth)

48666 HEATING OF INTERSTELLAR H I CLOUDS BY ULTRAVIOLET PHOTOELECTRON EMISSION FROM GRAINS. Watson, William D. (Cornell Univ., Ithaca, N. Y.). Astrophys. J.; 176: No. 1, 103-10(15 Aug 1972).

The physical processes and consequences of photoemission from interstellar grains in H I regions were investigated. For likely grain materials except ice, the photoemission is expected from laboratory data to be relatively efficient for photon energies of ~10 to 13.6 eV. It causes these interstellar grains to be positively charged in H I regions if the galactic ultraviolet flux is that indicated by recent observations. The ejected photoelectrons represent an energy input into interstellar H I clouds that is comparable to that from proposed fluxes of low-energy cosmic rays or x rays. Photoemission alone can maintain gas temperatures near 50°K in "standard" H I clouds. The exact value of the temperature depends on the grain density in the gas and the possible underabundance of carbon. (auth)

Solar Phenomena

Refer also to abstract 48135.

48667 (N-72-21829) ANALYSIS OF SOLAR ULTRAVIOLET LINES. Chipman, Eric (Smithsonian Astrophysical Observatory, Cambridge, Mass.). 15 Sep 1971. Contract NAS5-9274. 193p. (NASA-CR-125981). NTIS.

The formation of the strongest ultra-violet emission lines of Mg II, O I, C II, and C III in the solar atmosphere was studied in detail. The equations of statistical equilibrium and radiative transfer for each ion were solved using a general computer program that was capable of solving non-LTE line-formation problems for arbitrary atmospheric and atomic models. Interpreting the results in terms of the structure of the solar atmosphere, it was concluded that the HSRA atmosphere has a temperature too low by about 500 K near h = 1100 km and that a temperature plateau with $T_e \simeq 18{,}000$ K and width close to 60 km exists in the upper chromosphere. The structure of the solar atmosphere in the range 20,000 to 100,000 K and the effects of microturbulence on the formation of lines were also investigated. Approximate analytic line-formation problems were solved and more exact solutions were derived. An attempt was made to make the best possible fit to the Ca II K line center-to-limb profiles with a one-component atmosphere, with an assumed source function and microturbulent velocity. (auth) (STAR)

48668 (TRITA-EPP-71-33) SHOCK-FREE SOLUTIONS OF SOLAR WIND–COMETARY PLASMA FLOWS. Wallis, Max (Kungliga Tekniska Hogskolan, Stockholm (Sweden). Liege Univ. (Belgium). Institut d'Astrophysique). Apr 1972. 32p. Dep. NTIS (U. S. Sales Only).

The quasi-one-dimensional formulation of the MHD equations is used to describe the ionizing flow in the solar wind's passage through a cometary coma. A set of ordinary differential equations analogous to those of Biermann et al. describe the flow along the central stream-tube. The nature of the critical (magnetosonic) point is examined for spatial variations R^{-n} in the ionization rates; the point is a node with shock-free solutions only for locally low gradients, or for interactions with strong cooling. Otherwise, for realistic values $n \simeq 2$, the critical point is a focus and weakly shocked solutions are appropriate. However, in the external field of laboratory simulation experiments, the critical point disappears and the flow is, in any case, shock-free. (auth) (Sweden)

48669 NUMERICAL STUDIES OF MAGNETIC FIELD ANNIHILATION. Stevenson, J. C. (Long Island Univ., Greenvale, N. Y.). J. Plasma Phys.; 7: No. 2, 293-311(Apr 1972).

The behavior of a plasma permeated by a magnetic field, where the field possesses a hyperbolic neutral point, is considered. Results from numerical solutions of the magnetohydrodynamic formulation for such flows are reported. Problems are posed with the solar-flare models of Dungey, Sweet, & Petschek in mind. No evidence is found to support the idea that compression of the field lines near a hyperbolic null, in the presence of electrical resistance, can radically alter the geometry of those field lines (e.g., the formation of switch-off shocks). These computations do show that, for large values of the magnetic Reynolds number, a rate of annihilation, more rapid than that derived from order-of-magnitude estimates, is possible. (auth)

48670 SOLAR COSMIC-RAY FLARES IN FEBRUARY–APRIL 1969. Bazilevskaya, G. A.; Bayarevich, V. V.; Borovkov, L. P.; (and others). Izv. Akad. Nauk SSSR, Ser. Fiz.; 35: No. 12, 2530-7(Dec 1971). (In Russian).

A number of solar cosmic-ray flares were recorded in the stratosphere in the region of Murmansk and in the Antarctic during February–April, 1969. The distribution of such flares in interplanetary space was derived from these and related data. The coefficient of proton diffusion from cosmic rays was obtained for a series of energy intervals. (tr-auth)

48671 SOLAR COSMIC-RAY FLARES OF APRIL 11–18, 1969 AND EFFECTS ON THE LOWER ATMOSPHERE. Driatskii, V. M.; Krupitskaya, T. M.; Shirochkov, A. V. Izv. Akad. Nauk SSSR, Ser. Fiz.; 35: No. 12, 2538-42(Dec 1971). (In Russian).

A burst of solar cosmic radiation from April 11–18, 1969 is described and associated with polar-cap absorption. Theoretically calculated and experimental values of polar-cap absorption were compared on the basis of recording of galactic radio waves, and satisfactory agreement was obtained. The difference usually varied within the limits of 15%; on April 12 the difference reached 30%. (tr-auth)

48672 GENERATION OF NUCLEON AND ELECTROMAGNETIC COMPONENTS DURING A SOLAR FLARE. Gainova, L. E.; Ivanov, V. I.; Imazhanova, K.; Kolomeets, E. V. Izv. Akad. Nauk SSSR, Ser. Fiz.; 35: No. 12, 2543-6(Dec 1971). (In Russian).

The total number of electrons accelerated in a flare on August 28, 1966 was calculated according to the fluxes of high-energy x-ray and radio wave radiation. For a power-differential energy spectrum of electrons the exponent $\gamma \sim 4$. The energy spectrum of particles at maximum intensity was determined for the flare November 18, 1968 according to the intensity of the neutron component of cosmic radiation, and the change with respect to time was followed. The diffusion coefficient of particles generated on the Sun during this flare was independent of the energy (for 1 to 5 GeV), and was equal to 2×10^{22} cm$^2 \cdot$ sec^{-1}. (tr-auth)

48673 COSMIC PLASMA PHYSICS. Proceedings of the Conference Held at Frascati, Italy, September 20–24, 1971. Schindler, Karl (ed.). New York; Plenum Publishing Corporation (1972). 377p. $22.50. (CONF-710951).

Separate abstracts were prepared for the 44 full papers presented at the conference. (W.D.M.)

For abstracts of individual papers see: 48566–48569, 48579, 48632–48638, 48674–48692, 48713, 48750, 48772–48776, 48799–48802, 49555, and 49570.

48674 THERMAL ENERGY TRANSPORT IN THE SOLAR WIND. Montgomery, Michael D. (Los Alamos Scientific Lab., N. Mex.). pp 61-72 of Cosmic Plasma Physics. /Schindler, Karl (ed.). New York, Plenum Publishing Corp. (1972).

From Conference on cosmic plasma physics; Frascati, Italy (20 Sep 1971). See CONF-710951.

The present status of measurements of heat flux in the solar wind is summarized, and a comparison is made of these measurements with the theory for collision-dominated heat transport in a fully ionized medium developed by Spitzer and Harm (1953). A short discussion of some recent models is included to illustrate the role of thermal conduction in the expansion. In addition, a brief description of the steady-state solar wind is included in order to provide an observational background for this conference. (M.O.W.)

48675 SOLAR WIND NEAR THE SUN: THE SOLAR ENVELOPE. Burlaga, Leonard F. (Goddard Space Flight Center, Greenbelt, Md.). pp 73-9 of Cosmic Plasma Physics. /Schindler, Karl (ed.). New York, Plenum Publishing Corp. (1972).

From Conference on cosmic plasma physics; Frascati, Italy (20 Sep 1971). See CONF-710951.

This paper discusses the structure of the solar envelope and the physical processes that might occur in the envelope. The envelope is the region between $\approx 2R_\odot$ and $\approx$(25 to 50) $R_\odot$. (53 references). (auth)

48676 INFLUENCE OF NEUTRAL INTERSTELLAR MATTER ON EXPANSION OF THE SOLAR WIND. Fahr, H. J. (Univ., Bonn). pp 81-91 of Cosmic Plasma Physics. /Schindler, Karl (ed.). New York, Plenum Publishing Corp. (1972).

From Conference on cosmic plasma physics; Frascati, Italy (20 Sep 1971). See CONF-710951.

A brief theory is described for the energy exchanges in an expanding solar wind. Diagrams are given for helium and hydrogen densities at various positions relative to the sun. (M.O.W.)

48677 HYDROGEN–HELIUM EXPANSION FROM THE SUN. Weber, Edmund J. (Kitt Peak National Observatory, Tucson, Arizona). pp 93-100 of Cosmic Plasma Physics. /Schindler, Karl (ed.). New York, Plenum Publishing Corp. (1972).

From Conference on cosmic plasma physics; Frascati, Italy (20 Sep 1971). See CONF-710951.

Measurements on Mariner II had already indicated that the expanding solar wind is made up primarily of hydrogen ions with approximately 10% of helium as the most important minor constituent. A model is presented of the solar wind for this two-ion fluid and from it, the properties of the solutions are determined. The topology of the solutions for this multi-ion gas expansion is much more complex than for the simple hydrogen ion plasma case and yields new insight and vital information on the conditions under which a multi-ion gas is able to pass from the subsonic region and attain supersonic speeds. Such solar-wind-type solutions of this model will impose severe limitations on the temperatures of the ions at the base of the corona. In particular, for an isothermal model it can be clearly shown that a solar-wind-type solution can only exist if the temperature of the helium ion is approximately 4 times that of the hydrogen ions, which is, of course, what had been observed on various spacecrafts. (auth)

48678 GENERATION OF SHOCK PAIRS IN THE SOLAR WIND. Formisano, V.; Chao, J. K. (CNR, Rome. European Space Research Inst., Frascati, Italy). pp 103-4 of Cosmic Plasma Physics. /Schindler, Karl (ed.). New York, Plenum Publishing Corp. (1972).

From Conference on cosmic plasma physics; Frascati, Italy (20 Sep 1971). See CONF-710951.

A gradual velocity gradient originating near the Sun can build up a pressure pulse if the maximum velocity difference of the velocity gradient is greater than the local sound speed. This pressure pulse is convected out by the solar wind. It somewhat acts like two pistons which will generate forward and reverse shocks. A quantitative model of shock-pair generation is given, including the effect of the interplanetary magnetic field. The predicted position of shock pair generation and their strength (as measured by Mach number) agrees with observations. (auth)

48679 SPECTRAL ANISOTROPY OF ALFVEN WAVES IN THE SOLAR WIND. Voelk, Heinrich J.; Alpers, Werner (Max-Planck-Institut fuer Physik und Astrophysik, Garching, Ger.). pp 105-11 of Cosmic Plasma Physics. /Schindler, Karl (ed.). New York, Plenum Publishing Corp. (1972).

From Conference on cosmic plasma physics; Frascati, Italy (20 Sep 1971). See CONF-710951.

The propagation of Alfven waves from the outer corona into the interplanetary medium is discussed. This is done in the linear approximation for the wave amplitudes and in the approximation of geometrical optics, using the model of a stationary, spherically symmetric solar wind. A relation is derived for the directional distribution of the magnetic field vectors associated with the waves. (M.O.W.)

48680 EVIDENCE FOR WAVES AND/OR TURBULENCE IN THE VICINITY OF SHOCKS IN SPACE. Chao, J. K. (CNR, Rome. Univ., Rome). pp 113-22 of Cosmic Plasma Physics. /Schindler, Karl (ed.). New York, Plenum Publishing Corp. (1972).

From Conference on cosmic plasma physics; Frascati, Italy (20 Sep 1971). See CONF-710951.

The Rankine–Hugoniot equations for hydromagnetic shocks are extended to take into consideration the energy and momentum flux due to waves and/or turbulence in the vicinity of shocks. Eighteen shocks observed in space are analyzed. It is found, in order to satisfy the R–H relations with the values of measured parameters in space that waves and/or turbulence are needed for those shocks with Mach number greater than two, for the shocks with Mach number less than two, no waves and/or turbulence are needed to satisfy the R–H equations. A discussion of these waves and turbulence is given. (auth)

48681 COMETS IN THE SOLAR WIND. Biermann, L. (Max-Planck-Institut fuer Physik und Astrophysik, Munich). pp 123-35 of Cosmic Plasma Physics. /Schindler, Karl (ed.). New York, Plenum Publishing Corp. (1972).

From Conference on cosmic plasma physics; Frascati, Italy (20 Sep 1971). See CONF-710951.

Theoretical work done since 1964 on the existence, brightness, and size of the escaping hydrogen atmosphere of comets is described. Observations in the ultraviolet made with three different instruments on board OAO 2 and OGO 5 are discussed. Some remarks are given on the main changes since 1951 in the overall understanding of the interaction of the solar wind with comets. (W.D.M.)

48682 COMET-LIKE INTERACTION OF VENUS WITH THE SOLAR WIND. Wallis, Max K. (Univ., Liege. Royal Inst. of Tech., Stockholm). pp 137-40 of Cosmic Plasma Physics. /Schindler, Karl (ed.). New York, Plenum Publishing Corp. (1972).

From Conference on cosmic plasma physics; Frascati, Italy (20 Sep 1971). See CONF-710951.

Clear differences of the plasma flow past Venus from that outside the magnetosphere—in particular, absence of an upstream bow shock and of an extended ionospheric tail—characterize the Venus–solar wind interaction. Using data of the Venus probes, the interaction is interpreted from the point of view of ion creation in an extended Venusian atmosphere, similar to the outer coma of comets. The new ions both decelerate the solar wind and themselves gain large energies. A helium upper atmosphere with standard density ($10^{7\cdot 5}$ cm^{-3} at 200 km) but high temperature around 1500°K would fit the observations. Helium ions created out in the exosphere and accelerated generally inwards by the interplanetary fields should produce this hot atmospheric component. The total ionization rate is suitably large to support the theory of He^+ in the nightside ionosphere. Although most of the helium ions may be neutralized after transport into the lower atmosphere, the loss rate to the solar wind is still large; it should on the average equal the radiogenic production rate. (auth)

48683 LABORATORY EXPERIMENTS ON THE INTERACTION BETWEEN A PLASMA AND A NEUTRAL GAS. Danielsson, Lars (Royal Inst. of Tech., Stockholm). pp 141-8 of Cosmic Plasma Physics. /Schindler, Karl (ed.). New York, Plenum Publishing Corp. (1972).

From Conference on cosmic plasma physics; Frascati, Italy (20 Sep 1971). See CONF-710951.

In many plasma experiments it has been observed that there is an upper limit for the energy of the plasma as long as the plasma is not fully ionized everywhere. Attempts to increase the energy beyond this limit will only achieve additional ionization. The major experimental investigations are reviewed. (W.D.M.)

48684 WAVE MOTION IN TYPE-I COMET TAILS. Dobrowolny, Marino; D'Angelo, Nicola (European Space Research Inst., Frascati, Italy). pp 149-56 of Cosmic Plasma Physics. /Schindler, Karl (ed.). New York, Plenum Publishing Corp. (1972).

From Conference on cosmic plasma physics; Frascati, Italy (20 Sep 1971). See CONF-710951.

Filamentary structures are observed in Type-I comet tails, with sometimes a wavelike or helical appearance. Most features are occasionally in rapid motion. This behavior is analyzed in terms of a Kelvin–Helmholtz instability developing in the tail itself, rather than in the comet head as proposed by Ioffe. Reasonable agreement is obtained with the "parallel" and "perpendicular" wavelengths of the observed features, the periods of wave motion, and the growth rates. (auth)

48685 DIVERS SOLAR ROTATIONS. Wilcox, John M. Stanford Univ., Calif.). pp 157-64 of Cosmic Plasma Physics. /Schindler, Karl (ed.). New York, Plenum Publishing Corp. (1972).

From Conference on cosmic plasma physics; Frascati, Italy (20 Sep 1971). See CONF-710951.

An interesting variety of rotational properties is found in the photospheric and solar-wind plasma and magnetic fields. In both the photosphere and in the interplanetary medium near the Earth there is a tendency for the field patterns to rotate a few percent faster than the plasma patterns. The fields and plasmas show variability in their rotational properties on time scales of days or months, but averages over a few years tend to become much less variable, as shown by the results for long-lived sunspots, and by the rotating solar magnetic dipole. (W.D.M.)

48686 SOFT X-RAY SPECTRAL STUDIES OF SOLAR-FLARE PLASMAS. Doschek, G. A.; Meekins, J. F.; Kreplin, R. W.; Chubb, T. A.; Friedman, H. (Naval Research Lab., Washington, D. C.). pp 165-74 of Cosmic Plasma Physics. /Schindler, Karl (ed.). New York, Plenum Publishing Corp. (1972).

From Conference on cosmic plasma physics; Frascati, Italy (20 Sep 1971). See CONF-710951.

Soft x-ray spectra of solar flares were obtained from NRL Bragg crystal spectrometers flown on OSO-4 and OSO-6. In seven minutes these instruments scan a combined spectral range from 0.6 Å to ~14Å. The resonance lines of highly ionized elements, such as hydrogen-like Mg, Al, Si, S, and Ca, and helium-like lines of Mg, Al, Si, S, Ca, and Fe are strongly emitted in this spectral range during solar flares at temperatures ~20 × 10^6 K. The instrument scan time of seven minutes is sufficiently short to monitor the temporal behavior of the emission lines and continuum during the course of an event. From such studies it is found that flare plasmas are composed of several temperature regions characterized by different emission measures. For the large flare of November 2, 1969, the temperatures and values of the emission measures change as the flare develops. The data indicate that as the hottest portions (~20 × 10^6 K) of the flare plasma cool, a surrounding, relatively low-temperature plasma (~6 × 10^6 K) also cools coincident with an increase of emission measure. (auth)

48687 SIMILARITIES BETWEEN SOLAR FLARES AND LABORATORY HOT-PLASMA PHENOMENA. Bostick W. H.; Nardi, V.; Prior, W. (Stevens Inst. of Tech., Hoboken, N. J.). pp 175-84 of Cosmic Plasma Physics. /Schindler, Karl (ed.). New York, Plenum Publishing Corp. (1972).

From Conference on cosmic plasma physics; Frascati, Italy (20 Sep 1971). See CONF-710951.

Similarities exist among fine-structure details (and related phenomena) of solar flares and of the current sheath in a plasma coaxial accelerator. The production mechanism of x ray and high-energy particles can be consistently related to the decay process of a filamentary magnetic structure in both solar and laboratory phenomena. Buildup and explosive decay of this structure are described by a self-consistent theory for fields and phase-space densities. (auth)

48688 GYROMAGNETIC RADIATION FROM BUNCHED ELECTRONS. Mangeney, Andre (Observatoire de Meudon, France). pp 185-9 of Cosmic Plasma Physics. /Schindler, Karl (ed.). New York, Plenum Publishing Corp. (1972).

From Conference on cosmic plasma physics; Frascati, Italy (20 Sep 1971). See CONF-710951.

The theory of coherent emission by bunches of electrons spiraling in a magnetic field has attracted the attention of many authors since the discovery of pulsars. Some doubt has been expressed about the possibility that such a mechanism could work under cosmic conditions. In the present paper it is proposed, on the contrary, that such a radiation mechanism could be invoked for the interpretation of a particular kind of solar radio burst, the so-called "stationary" Type-IV burst. (auth)

48689 OBSERVATIONS OF CORONAL MAGNETIC FIELD STRENGTHS AND FLUX TUBES AND THEIR STABILITY. Rosenberg, Hans (Astronomical Inst., Utrecht). pp 191-3 of Cosmic Plasma Physics. /Schindler, Karl (ed.). New York, Plenum Publishing Corp. (1972).

From Conference on cosmic plasma physics; Frascati, Italy (20 Sep 1971). See CONF-710951.

At the Utrecht Observatory a 60-channel solar radio spectrograph is operating. In the relevant period the frequency bandwidth was 160 to 320 MHz. The instrument is particularly well suited for the study of short-time scale fluctuations in weak or strong continua, due to a differentiating technique (De Groot and Van Nieuwkoop, 1968; Van Nieuwkoop, 1971). In addition to some unclassified phenomena, all well known types of solar radio bursts have been observed and, in particular, a wealth of detailed structure in these bursts. The details in Type IV continuum emissions are considered. Type-IV storms are generally believed to be due to synchrotron radiation of mildly relativistic electrons. (auth)

48690 COLLISIONLESS SHOCKS. Paul, J. W. M. (United Kingdom Atomic Energy Authority, Abingdon, Eng.). pp 293-303 of Cosmic Plasma Physics. /Schindler, Karl (ed.). New York, Plenum Publishing Corp. (1972).

From Conference on cosmic plasma physics; Frascati, Italy (20 Sep 1971). See CONF-710951.

The discussion is restricted to electrostatic turbulence with (i) scale $\ll L_s$ = shock width (i.e., microturbulence), (ii) fluctuating potential $\phi \ll (\kappa T_e/e)$ so that large-angle deflection and trapping are not important (i.e., weak turbulence). (W.D.M.)

48691 NONLINEAR EVOLUTION OF FIREHOSE-UNSTABLE ALFVEN WAVES. Elsaesser, K.; Schamel, H. (Max-Planck-Institut fuer Physik und Astrophysik, Munich). pp 305-10 of Cosmic Plasma Physics. /Schindler, Karl (ed.). New York, Plenum Publishing Corp. (1972).

From Conference on cosmic plasma physics; Frascati, Italy (20 Sep 1971). See CONF-710951.

The time evolution of firehose-unstable Alfvén waves is considered within the FCR approximation of Kennel and Sagdeev (1967). By including higher order terms in the current a nonlinear amplitude equation is obtained for the magnetic field perturbations. Discarding wave correlations of fourth order, a nonlinear spectrum equation is derived that allows stationary solutions if and only if the growth rate γ becomes zero. The influence of the nonlinear terms on the equilibrium increases with decreasing wave vector. The self-interaction of a single mode is studied for moderate and large values of the plasma parameter β^+; an explosive behavior of the wave amplitude is found if $\int_0^\infty \gamma dt$ exceeds some critical value depending on the initial amplitude. (auth)

48692 FERMI ACCELERATION IN INTERPLANETARY SPACE. Wibberenz, G.; Beuermann, K. P. (Univ., Kiel). pp 339-48 of Cosmic Plasma Physics. /Schindler, Karl (ed.). New York, Plenum Publishing Corp. (1972).

From Conference on cosmic plasma physics; Frascati, Italy (20 Sep 1971). See CONF-710951.

Fermi acceleration of low-energy cosmic rays in interplanetary space is of interest for several reasons. In principle, the coefficients describing energy diffusion in a Fokker–Planck equation can be obtained from the full spectrum of electromagnetic fluctuations. If only Alfvén waves traveling parallel to the magnetic field are involved, the Fermi process can be related to the pitch–angle diffusion coefficient and therefore to the spectrum of purely magnetic fluctuations. The net effect depends on the relative amount of power contained in Alfvén waves as compared to irregularities frozen in the solar wind. It is shown that the Fermi effect may partly cancel the adiabatic deceleration for protons in the MeV range and may become dominant below 1 MeV. The overall effect depends strongly on the variation of the electromagnetic fluctuations with distance from the Sun. (auth)

48693 SPACE PHYSICS. White, R. Stephen. New York; Gordon and Breach, Science Publishers, Inc. (1970). 327p.

This work condenses and unifies the separate disciplines of the Earth's atmosphere, ionosphere, radiation belts, magnetic cavity, the Sun, and interplanetary space. It offers a thorough treatment of solar cycle variations and their effects on the Earth's environment. Currently accepted theories are summarized and criticized. (W.D.M.)

48694 NONLINEAR DYNAMO WAVES. Stix, M. (Univ., Goettingen, Ger.). Astron. Astrophys.; 20: No. 1, 9-12(Aug 1972).

Steenbeck and Krause's idea that the α effect, an emf parallel to a mean magnetic field occurring in turbulence which lacks reflexional symmetry, is inhibited by the exponentially growing field, is examined by means of a simple model. For small fields the same α as in the linear theory is used; but α is set to zero if the field exceeds a certain value. The influence of this "cutoff α-effect" on the one-dimensional dynamo waves of Parker (1955b) is studied. In particular, oscillatory antisymmetric dynamos are computed and compared with the solar cycle. It is found that the oscillation periods of such solutions are about twice the periods resulting from the linear theory, if the dynamo number, describing the magnitude of the induction effects, is 7 times the critical value or larger, thus improving the agreement between theory and observation. Moreover, for such highly supercritical dynamo numbers the period slightly decreases with increasing field amplitude, reproducing the observational fact that weak cycles usually last longer than strong cycles. The solutions also show the characteristic symmetry between the rising and falling parts of the cycle. (auth)

48695 TYPE IIIb BURST: A PRECURSOR OF DECAMETRE TYPE III RADIO-BURST. de la Noe, J.; Boischot, A. (Observatoire, Meudon, France). Astron. Astrophys.; 20: No. 1, 55-62(Aug 1972).

High-resolution and high-sensitivity spectra of decameter noise storms show the presence of a large number of split-pair and single narrow-banded bursts (named stria-bursts) which have a strong tendency to appear in chains which drift in frequency in a manner similar to the Type III bursts. The main characteristics of such chains (named Type IIIb bursts) are studied. It is shown in particular that Type IIIb are often precursors of a normal Type III burst. Some conclusions about the nature of the exciter of Type IIIb and Type III bursts are presented. (auth)

48696 Eu, La, AND Sm IN SUNSPOT SPECTRA. Molnar, H. (Univ., Goettingen, Ger.). Astron. Astrophys.; 20: No. 1, 69-72(Aug 1972).

Abundances of Eu, La, and Sm were derived using high-resolution sunspot spectra. The results are: $\log {}^{Eu}\epsilon = 0.70 \pm 0.30$, $\log {}^{La}\epsilon = 2.14 \pm 0.27$, $\log {}^{Sm}\epsilon = 2.30 \pm 0.35$ in the scale $\log {}^{H}\epsilon = 12.00$. Sm shows no, La a slight, and Eu a strong dependennce of $\log \epsilon$ on the lower excitation potential. This indicates the presence of systematic errors in the oscillator strengths used. Some newly identified lines in the umbral spectrum are listed. (auth)

48697 CALCULATION OF SOLAR CO VIBRATION–ROTATION LINE PROFILES AND EQUIVALENT WIDTHS. Berger, Richard Alan (Observatoire de Meudon, Verrieres-le-Buisson, France); Lena, Pierre. Astron. Astrophys.; 20: No. 1, 111-13 (Aug 1972).

Calculations of the profile and equivalent width of the P 36 line of the infrared fundamental band of CO were undertaken, assuming LTE. Results for the BCA and HSRA solar models were compared. The line is shown to be optically thick and its profile and width strongly dependent on model assumptions of temperature, pressure, and microturbulent velocity. The calculations indicate that the line is mostly formed in the region of temperature minimum for both models. Projected observations should therefore yield specific data on the physical conditions in this region. (auth)

48698 TEMPERATURE AND EMISSION MEASURE DEDUCED BY CORONAL VISIBLE LINES. Landini, M.; Monsignori Fossi, B. C. (Osservatorio Astrofisico di Arcetri, Florence). Astron. Astrophys.; 20: No. 1, 161-2(Aug 1972).

Coronal electron temperature versus emission measure is obtained from visible lines, by means of recent computations of ionization balance for coronal ions. Comparison is made with similar results obtained by Pottasch for euv lines. (auth)

48699 PERIODIC HEATING MECHANISM IN SOLAR FLARES. Glencross, W. M.; Craig, I. J. D. (University Coll., London). Nature (London) Phys. Sci.; 238: No. 82, 50-2(24 Jul 1972).

Observations of periodic x-ray flares are described. The flare origin is suggested to be energy transfer from oscillating layers low in the chromosphere. (auth)

48700 ^{26}Al AND ^{53}Mn PRODUCED BY SOLAR-FLARE PARTICLES IN LUNAR ROCK AND COSMIC DUST. Tanaka, S.; Sakamoto, K.; Komura, K. (Tokyo Univ.). J. Geophys. Res.; 77: No. 23, 4281-8(10 Aug 1972).

With the use of the excitation functions for ^{26}Al-producing reactions, the rates of ^{26}Al production in interplanetary targets (lunar rocks 10017 and 12002 and cosmic dust) by solar-flare particles were calculated. The same calculations were also made for ^{53}Mn with the estimated excitation functions. The energy spectrum of solar protons averaged over the 1956–1966 solar cycle was used as a guide for the unknown flux over the last few million years with the assumption that the ratio of H/He was 6. It is shown that the half-value of the average flux reproduces rather well the observed depth profiles of these nuclides in the lunar rocks and the observed limit of ^{26}Al in marine sediment. A slight discrepancy between the calculated and the observed pattern of ^{53}Mn at the top surface of lunar rocks is discussed in terms of surface erosion and other effects. The present calculations are compared with earlier ones. (auth)

48701 FORMATION OF ORDINARY CHONDRITES. Wasson, John T. (Max-Planck-Institut fuer Chemie, Mainz. Univ. of California, Los Angeles). Rev. Geophys. Space Phys.; 10: No. 3, 711-59(Aug 1972).

Most of the chemical and mineralogical properties of the ordinary chondrites were established by processes that occurred in the solar nebula during a short time span near the time of formation of the solar system. Four separate and distinct fractionation events appear to have been involved in their formation from more primitive material of mean solar-system composition. In order of occurrence these were (1) a refractory-element fractionation, which resulted in the lower Mg/Si, Ca/Si, Al/Si, and other refractory-element/Si ratios relative to C1 chondrites; (2) a siderophilic-element fractionation, which produced the monotonic reduction of siderophilic-element/Si ratios as one proceeds from the H group toward the LL group and the variation in ratios of one siderophilic element to another through this sequence; (3) a fractionation of slightly volatile elements (such as Cu, Ga, and Ge), probably during chondrule formation; and (4) a fractionation of highly volatile elements, probably by thermal metamorphism while the chondritic material was stored in planetesimals of the meter-to-100-meter size range. In each of the four cases the most plausible fractionation mechanism involves a separation of gases from solids. The ambient temperature in the planetary portion of the solar nebula during the formation of these chondrites appears to have been characterized by two maximums. (112 references) (auth)

48702 SOLAR MAGNETIC FIELDS DERIVED FROM HYDROGEN ALPHA FILTERGRAMS. McIntosh, Patrick S. (National Oceanic and Atmospheric Administration, Boulder, Colo.). Rev. Geophys. Space Phys.; 10: No. 3, 837-46(Aug 1972).

The distribution and polarity of solar magnetic fields can be inferred from photographs taken with narrow band-pass filters centered on the Hα spectral line. Structures observed in Hα, including filaments, filament channels, fibrils, arch-filament systems, and plage corridors are used to infer positions of neutral lines in the radial component of the solar magnetic fields. This source of magnetic-field information, although it is not strictly objective and quantitative, offers a number of important advantages over the solar magnetograph. The inferred data can be obtained with the existing global network of flare patrol observatories at low cost, high speed, and complete reliability from day to day. Patrol films allow the filling of interruptions in magnetograph data and the extension of the magnetic-field data base back in time to the first spectroheliograms near the beginning of the century. The large-scale Hα patterns are more precisely outlined than their large-scale counterparts on magnetograms. The continuity of Hα markers of polarity reversals from active centers to quiescent, large-scale structures reveals associations and patterns not previously studied. The inferred magnetic data have important applications in solar-activity forecasting, direction of interplanetary-sector boundaries, and the inference of structures in the solar corona. (auth)

48703 ABSOLUTE MEASUREMENT OF THE SOLAR BRIGHTNESS IN THE SPECTRAL REGION BETWEEN 100 AND 500 MICRONS. Stettler, P. (Swiss Federal Inst. of Tech., Zurich); Kneubuehl, F. K.; Mueller, E. A. Astron. Astrophys.; 20: No. 2, 309-12(1 Sep 1972).

The solar brightness temperature at wavelengths between 110 and 500 μ was measured with a balloon-borne lamellar-grating interferometer. A high-temperature black body served as absolute calibration source. The experimental results are compared with those of other research groups and with the empirical HSRA model. The agreement with the model is fairly good for wavelengths greater than 300 μ. (auth)

48704 TABLE OF SOLAR DIATOMIC MOLECULAR LINES: SPECTRAL RANGE 4900 TO 6441 A. Sotirovski, P. (Observatoire, Meudon, France). Astron. Astrophys., Suppl. Ser.; 6: No. 1, 85-115(May 1972).

The table of diatomic molecular lines observed in sunspot spectra ($\lambda\lambda$ 4900 to 6440 Å) contains about 6000 lines; about 10% of them are masked by atomic lines; whilst others are blended with solar molecular or telluric lines. A total of seven molecules were identified in the three sunspots. An introductory text gives a detailed description of each column of the table. For each identified line the rotation branch, quantum number, and the vibration band are indicated. Unfortunately only about 80% of the measured lines are identifiable owing to the lack of laboratory data. The equivalent widths were measured for all lines with profiles as free from blend as possible, the effect of scattering from the photosphere being taken into account. For other lines estimates are given. Because the calibration curve is not available for wavelengths greater than 6100 Å, the measures stop there. (auth)

48705 GENERATION OF MAGNETIC FIELDS IN ASTROPHYSICAL BODIES. IX. A SOLAR DYNAMO BASED ON HORIZONTAL SHEAR. Lerche, I.; Parker, E. N. (Univ. of Chicago). Astrophys. J.; 176: No. 1, 213-23(15 Aug 1972).

In view of the uncertainty in the angular velocity $\Omega(r,\theta)$ in the solar interior, the general behavior of the solar dynamo for horizontal shear $(\partial\Omega/\partial\theta)$ was worked out for comparison with the earlier models based on vertical shear $(\partial\Omega/\partial r)$. The horizontal shear produces greater complexity, with the fields at the surface migrating toward the equator (for a uniform distribution of shear and cyclonic convection) and a layer of counter migrating fields at the bottom of the dynamo. More important, perhaps, the horizontal shear excites the even and odd modes equally, whereas vertical shear excites the odd mode before the even mode. (auth)

48706 LAGRANGIANS, VARIATIONAL PRINCIPLES, AND KINEMATIC-DYNAMO EQUATIONS. Lerche, I. (Univ. of Chicago). Astrophys. J.; 176: No. 1, 225-33(15 Aug 1972).

The kinematic-dynamo equations were investigated from a Lagrangian point of view. It is demonstrated that (i) the dynamo equations (which are not self-adjoint) follow from an extremal variation of a Lagrangian; (ii) the equations adjoint to the dynamo equations also follow from an extremal variation of the same Lagrangian; (iii) the Lagrangian approach automatically gives a variational principle for computing the eigenvalues of the dynamo equations subject to the boundary conditions at hand. In view of (a) the paucity of analytic solutions (and their eigenvalues) to the dynamo equations for complicated fluid flows and (b) the slowness of convergence of numerical investigations of the eigenvalues of dynamo equations, it is believed that the technique developed—which is capable of handling complicated fluid flows and which does not have any numerical convergence problems—is a valuable addition to the methods used for discussing dynamo action as it occurs in astrophysical bodies. (auth)

48707 NYQUIST CRITERION FOR KINEMATIC-DYNAMO ACTION. Lerche, I. (Univ. of Chicago). Astrophys. J.; 176: No. 1, 235-7(15 Aug 1972).

Using the dispersion relation given elsewhere describing normal-mode frequencies of a large-scale magnetic field under incompressible, homogeneous, stationary velocity turbulence, the general Nyquist criterion is set up which guarantees the existence of growing modes. The criterion is valid for any assumed form of the correlation function of the velocity turbulence. This Nyquist instability criterion is set up both as a guide to those who may wish to pursue the problem further, and to correct erroneous criteria given elsewhere by Krause and Roberts. (auth)

48708 ROCKET OBSERVATION OF Ar XII–XVI, Ca XIV–XVIII, AND Fe XIV, XV, XXIV IN THE EXTREME-ULTRAVIOLET SPECTRUM OF A SOLAR FLARE. Purcell, J. D.; Widing, K. G. (U. S. Naval Research Lab., Washington, D. C.). Astrophys. J.; 176: No. 1, 239-47(15 Aug 1972).

The lithium-like doublets of S XIV, Ar XVI, and Ca XVIII are identified in the 300 to 450 Å region by extrapolation of solar wavelengths and term intervals in the isoelectronic sequence. A possible observation of Fe XXIV in the flare is discussed. The solar blend at 417 Å involving S XIV and the Fe XV intersystem line is resolved. The singlet resonance lines of S XIII, Ar XV, and Ca XVII are also found in the flare spectrum by isoelectronic extrapolation. Ca XIV and Ca XV are identified on the basis of laboratory wavelengths. The problem of the identification of boron-like Ar XIV and Ca XVI is discussed. The weakness of argon lines relative to calcium lines in the flare is consistent with a solar abundance of argon less than calcium. An electron density of 3×10^{10} in the flare core is estimated from the intensity ratio of the Fe XIV lines at 211 and 219 Å. (auth)

48709 RADIATIVE LIFETIMES FOR SOME RESONANCE TRANSITIONS OF Fe I AND Fe II IN THE REGION BETWEEN 2300 A AND 3050 A, AND THE APPLICATION TO IRON ABUNDANCE DETERMINATIONS IN THE SUN AND IN THE QSO PHL 938. Assousa, George E.; Smith, William Hayden (Princeton Univ., N. J.). Astrophys. J.; 176: No. 1, 259-66(15 Aug 1972).

The radiative lifetimes for five Fe I and three Fe II upper states which result in transitions terminating in the ground state were obtained with an electron-beam phase-shift apparatus. Lifetimes ranging from 8.4 to 2.6 ns were found for the various transitions. These were converted to absolute oscillator strengths by using relative transition probabilities taken from the literature. The resulting oscillator strengths were applied to problems of the solar iron abundance and the column densities of iron observed in the spectrum of PHL 938. (auth)

48710 OSCILLATOR STRENGTHS FOR ALLOWED nd–n'f TRANSITIONS IN THE HELIUM ISOELECTRONIC SEQUENCE. Brown, Robert T. (EG and G, Inc., Las Vegas, Nev.); Cortez, Jose-Luis M. Astrophys. J.; 176: No. 1, 267-70(15 Aug 1972).

Variational wave functions were used to obtain wavelengths and oscillator strengths for nd-n'f transitions, through n and n' equal to 8, in the helium isoelectronic sequence through S xv. The trial functions were configuration-interaction expansions in members of a denumerably complete basis set (Sturmian functions). Of the 660 transitions studied, observed wavelengths were available for only 10, all in He I. Differences between observed and calculated values ranged from 0.07% to less than 0.004%. Agreement between dipole-length and dipole-velocity oscillator strengths for the great majority of transitions was to within 1 or 2%. The accuracy of the wave functions was not great enough to provide reliable values for $\Delta n = 0$ transitions. (auth)

Galaxies

Refer also to abstracts 48642, 48652, and 49171.

48711 EFFECT OF IONIZATION LOSSES ON THE LIFETIME OF COSMIC RAYS IN THE GALAXY. Velinov, P. Izv. Akad. Nauk SSSR, Ser. Fiz.; 35: No. 12, 2466-71(Dec 1971). (In Russian).

Expressions for the lifetime T_0 of cosmic rays were obtained relative to the ionization loss in the interstellar medium. T_0 depends essentially on the energy of particles, and in the realm of nonrelativistic energies is comparable with T_e, the average lifetime relative to catastrophic energy losses, E_k. For different groups of nuclei the energy E_k was calculated, where $T_0 \simeq T_e$. E_k is approximately 300 to 600 MeV/nucleon, and in the open model of the galaxy, is 100 to 400 MeV/nucleon. Possible acceleration of cosmic particles in interstellar space is considered, i.e., the statistical Fermi-type acceleration that leads to an increase of T_0. (tr-auth)

48712 STATIC PROPERTIES OF GALAXIES IN THE CLUSTER ABELL 2199. Rood, Herbert J.; Sastry, Gummuluru N. (Wesleyan Univ., Middletown, Conn.). Astron. J.; 77: No. 6, 451-8(Aug 1972).

For 170 galaxies in a 2-square-degree area of Abell 2199, a catalogue is presented of radial and angular coordinates, major axes, ellipticities, position angles of major axis, color, and morphological type. There is a tendency for the galaxies to lie along the major axis of the central cD galaxy. Statistical tests indicate that galaxies with small ellipticity, major axis perpendicular to that of the cD galaxy, red color, elliptical and S0 type tend to be concentrated toward the cluster center. Ellipticals and blue galaxies tend to lie along the major axis of the cD galaxy. (auth)

48713 DYNAMICAL BEHAVIOR OF THE INTERSTELLAR GAS, FIELD, AND COSMIC RAYS. Parker, E. N. (Univ. of Chicago). pp 195-202 of Cosmic Plasma Physics. /Schindler, Karl (ed.). New York, Plenum Publishing Corp. (1972).

From Conference on cosmic plasma physics; Frascati, Italy (20 Sep 1971). See CONF-710951.

A brief summary is given of the large-scale instability associated with the galactic magnetic field and cosmic rays. The origin of the magnetic field is briefly considered. (W.D.M.)

48714 RADIAL VELOCITIES OF GALAXIES. II. Chincarini, Guido (Univ. of Texas, Austin); Rood, Herbert J. Astron. J.; 77: No. 6, 448-50(Aug 1972).

A list of radial velocities of galaxies derived from spectrograms obtained in 1971 with the Carnegie image-tube Cassegrain spectrograph attached to the KPNO 84-inch telescope is presented. The list includes data for a 7° × 4° region centered near R.A. = 12h18m, Dec. = 29°. It contains members of the NGC 4274 group with $\langle V_0 \rangle = 882$ km/sec, the NGC 4131 group with $\langle V_0 \rangle = 3969$ km/sec, and the Coma cluster. Four galaxies in the compact VV115 group, Seyfert's group, have radial velocities near $\langle V_0 \rangle = 4454$ km/sec, while a fifth has $V_0 = 20\ 137$ km sec. This Sc galaxy may be a background object. The distorted double galaxy, No. 98 in Arp's Atlas, has practically no velocity difference. It could be a tidally interacting system. (auth)

48715 HIGH ENERGY GAMMA RADIATION FROM THE GALACTIC CENTRE REGION. Browning, R.; Ramsden, D.; Wright, P. J. (Southampton Univ., Eng.). Nature (London); 238: No. 5360, 138-9(21 Jul 1972).

Balloon observations of gamma-ray sources near the galactic centre are described. These show good correlation with known x-ray sources. No diffuse emission was observed; gamma rays apparently originate from point sources. (auth)

48716 STRUCTURE AND MOTIONS IN THE CARINA SPIRAL FEATURE. Humphreys, Roberta M. (Steward Obervatory, Tucson, Ariz.). Astron. Astrophys.; 20: No. 1, 29-48(Aug 1972).

The distribution and kinematics of the luminous young stars in the Carina spiral feature ($l = 282° - 305°$) were investigated and compared with the available data for the neutral hydrogen gas in the same region. The space distribution of these luminous stars revealed a well-defined spiral feature from 1.5 to 6 kpc from the Sun. It is suggested that both the young stars and hydrogen gas are observed to large distances along the line of sight in Carina. A detailed comparison of the velocities of the stars and dense gas yielded a good overall correlation. A noticeable discrepancy at $l = 290°$ between the stellar and gas motions is discussed. Velocity residuals for the stars indicate systematic motions of 6 km/s between the sides of the spiral feature. These streaming motions should be shared by the associated gas. (auth)

48717 STUDY OF THE INTERSTELLAR EXTINCTION IN THE CARINA–CENTAURUS REGION. Loden, L. O. (Astronomical Observatory, Uppsala); Sundman, A. Astron. Astrophys.; 20: No. 1, 49-53(Aug 1972).

An attempt was made to estimate the general distribution of interstellar obscuring matter, particularly the behavior of the color excess, in the Carina–Centaurus region of the Milky Way from photoelectric UBV observations of a selection of 1000 stars and to find some applicable value of the coefficient R for some particular regions. The result indicated that the correlation between color excess and apparent distance modulus is very local in character and that R is probably not constant over the whole region. As a reasonable mean value of R, 3.5 was accepted. (auth)

48718 SUPERNOVA REMNANTS IN THE LARGE MAGELLANIC CLOUD. Milne, D. K. (CSIRO, Sydney). Astrophys. Lett.; 11: No. 4, 167-71(Aug 1972).

Confirmatory radio observations are given for 11 possible supernova remnants in the Large Magellanic Cloud. These sources are over-luminous compared with remnants in the Galaxy and it is suggested that they have evolved from the early-type supergiants so abundant in the Large Cloud. (auth)

48719 HIGH-RESOLUTION OBSERVATIONS OF THE NUCLEUS, SPIRAL STRUCTURE, AND ELLIPTICAL COMPANIONS

OF M31 AT 1415 MHz. Van Der Kruit, P. C. (Sterrewacht, Leiden). Astrophys. Lett.; 11: No. 4, 173-80(Aug 1972).

Observations of M31 and its companions with the Westerbork Synthesis Radio Telescope at 1415 MHz are reported. The central radio source is resolved in a point source in the nucleus and a smooth component of about 0.5 kpc diameter, in which there are several unresolved condensations. The nuclear source of 6 mfu, with a diameter of probably less than 35 pc, is 17 times weaker than Sgr A. The average radio brightness of the spiral arms is confirmed to be about 0.3 K and no polarization above 35% is detected. Contrary to the Cambridge observations several condensations of radio emission are noted in the spiral arms, which in some cases seem to be related to concentrations of emission nebulae. The elliptical companions are all weaker than 5×10^{34} erg sec^{-1} within a diameter of 50 pc. Pooley's spur-feature from M31 towards M32 is also present on the map, when the beam is smoothed to 3.9×5.4 arc min. (auth)

48720 POSSIBLE MODELS FOR THE EXTENDED X-RAY SOURCE AT THE GALACTIC CENTER. Maraschi, L. (Univ., Milan. CNR, Milan); Treves, A. Astrophys. Lett.; 11: No. 4, 211-15(Aug 1972).

X- and γ-ray observations from the direction of the galactic center are discussed. It is shown that the x-ray and γ-ray emission can be explained by inverse Compton scattering off the 100 μm radiation if the magnetic field in the extended nonthermal radio source located within the 100 μm source is 3×10^{-6} Gauss. If the spectrum of the x-ray emission were found to be a thermal bremsstrahlung, a possible explanation would be that the x-ray source is not extended but made up of a number of discrete sources. Alternatively the x-ray emission may arise from inverse bremsstrahlung of suprathermal protons responsible for heating the grains that emit the 100 μm radiation. (auth)

48721 FORMATION OF CLUSTERS OF GALAXIES; PROTOCLUSTER FRAGMENTATION AND INTERGALACTIC GAS HEATING. Sunyaev, R. A.; Zeldovich, Ya. B. (Inst. of Mathematics, Moscow). Astron. Astrophys.; 20: No. 2, 189-200 (1 Sep 1972).

Shock waves appearing in the nonlinear stage of growth of the initial density perturbations give a distinctive distribution of temperature and density to a condensed gas. The scale of the perturbations $M \sim 10^{12}$ to 10^{14} $M_{\odot}$ is typical of the theory of adiabatic density perturbations and is associated with protoclusters of galaxies. The epoch of formation of protoclusters of galaxies is chosen to correspond to the redshift $z_c \sim 3$ to 5, in agreement with results for quasars and powerful radio source counts. Part of the gas (1%) condenses adiabatically and has a low temperature and high density. A hypothesis on origin of dense bodies (quasars and galaxy nuclei) from such gas is advanced. After heating, about 20% of the gas cools to 10^4°K, and it was assumed that this gas goes into galaxies. The remaining gas is heated up to 10^6°K, which explains the observed complete ionization of the intergalactic gas. The paper deals with dynamics of shock waves, heat processes in the gas, its radiation and contribution to the x-ray background as well as the process of fragmentation of the cold gas to form the above mentioned objects, starting from the cosmological model of the hot Universe with small density perturbations. (auth)

48722 MODEL OF THE INTERSTELLAR MEDIUM. II. INTERPRETATION OF THE Na/Ca^+ RATIO. Pottasch, S. R. (Kapteyn Astronomical Inst., Groningen, Netherlands). Astron. Astrophys.; 20: No. 2, 245-58(1 Sep 1972).

An attempt is made to explain the observed variation of the ratio Na/Ca^+ in interstellar "clouds", assuming the abundances of sodium and calcium are everywhere the same. The results of this analysis are applied to about thirty observed "clouds", and it is shown that it is possible to derive values of electron temperature, electron density, and state of ionization for each "cloud". It is shown that at least two and possibly four different groups of clouds exist. These results are compared with other observations of the interstellar medium, especially the pulsar dispersion measures and the low frequency radio absorption measurements. A discussion of the "cloud" properties is given. (auth)

48723 STABILITY OF A ONE DIMENSIONAL STELLAR SYSTEM. Doremus, J. P. (Univ., Nancy); Feix, M. R. Astron. Astrophys.; 20: No. 2, 259-62(1 Sep 1972).

The stability of a double water-bag is investigated for plane one dimensional systems. For each bag, the eigenfrequencies and the eigenfunctions are computed and are used as orthonormal bases for the expansion of the perturbed field. The eigenfrequencies for the total system are subsequently computed and it is found that the system is stable as long as the stars on the inner contour rotate in a shorter time than the stars on the outer contour. (auth)

48724 DENSITY OF H_2 MOLECULES IN DARK INTERSTELLAR CLOUDS. de Jong, Teije (Sterrewacht, Leiden). Astron. Astrophys.; 20: No. 2, 263-74(1 Sep 1972).

The equilibrium established through reactions between H atoms, H_2 molecules, H^+ ions, H^- ions, H_2^+ ions, H_3^+ ions and electrons in a dark cloud, including the effect of low-energy cosmic rays, was calculated. Two cases were considered. In case (A) H_2 molecules are formed by surface recombination of H atoms on grains, $2H + \text{grain} \rightarrow H_2 + \text{grain}$, and by associative detachment of the H^- ion, $H^- + H \rightarrow H_2 + e$; in case (B) only the latter process is operative. The results of the calculations for case (B) demonstrated that even if H_2 formation on the surface of grains is a very inefficient process, the presence of H_2 molecules in dark clouds can be explained. Observations of atomic and molecular hydrogen in the direction of clouds and observed upper limits of the H_2^+ density were not inconsistent with the results but it is as yet impossible to decide between cases (A) and (B). The diffuse interstellar absorption bands cannot be explained by preionization of the negative hydrogen ion if the H^- density in dark clouds is as low as calculated. Gas kinetic formation of other molecules may possibly proceed through negative ions of other elements. (auth)

48725 ABSORPTION-LINE SPECTRUM OF MARKARIAN 231. Adams, Thomas F. (Univ. of Arizona, Tucson). Astrophys. J.; 176: No. 1, L1-3(15 Aug 1972).

The faint absorption lines observed by Adams and Weedman in the absorption-line Seyfert galaxy Markarian 231 are shown to be a composite A-type stellar spectrum originating in the nucleus with the same redshift as the emission system. Narrow [O II] λ3727 emission is also observed at the same redshift coming from an extended region around the nucleus. The presence of strong interstellar absorption lines blueshifted with respect to the nucleus is again confirmed. The similarity between Markarian 231 and the OSO 3C 273 is discussed briefly. (auth)

48726 EVIDENCE FOR A PHYSICAL CONNECTION BETWEEN MARKARIAN 205 AND NGC 4319. Lynds, Roger (Kitt Peak National Observatory, Tucson, Ariz.); Millikan, A. G. Astrophys. J.; 176: No. 1, L5-8(15 Aug 1972).

New direct photographs and spectroscopic material are discussed in relation to the finding by Arp that there is a filament connecting Markarian 205 and NGC 4319, objects of greatly differing redshift. The new material appears to raise doubts concerning the nature of the feature reported by Arp and tends, to a small degree, to support a more conventional interpretation of Markarian 205 as a Seyfert galaxy located at its indicated Hubble distance. (auth)

48727 GAS CONTENT OF GALAXIES. Quirk, William J. (California Inst. of Tech., Pasadena. Carnegie Institution of Washington, D. C.). Astrophys. J.; 176: No. 1, L9-14(15 Aug 1972).

The following hypothesis is suggested: If the gas in a galaxy is Jeans unstable according to the criterion of Goldreich and Lynden-Bell, efficient star formation results. No attempt is made to describe how star formation occurs. One consequence of this hypothesis is that if the gas at a particular radius in a galaxy is dense enough to be Jeans unstable, star formation will deplete the gas until it is just barely Jeans unstable. Provided one knows the rotation curve for a galaxy and the sound speed of the gas, it should be possible to predict the density at which the gas will become Jeans unstable, and thus the density of gas as a function of radius in the galaxy. The densities computed in this way are compared with the observed surface densities of several external galaxies. The hypothesis is found to predict, roughly, the gas surface densities that are observed in the outer regions of these galaxies, but to overestimate the densities in the inner half of the galaxies. The overestimate may be due to the effects of density-wave shocks. The hypothesis would also seem to explain the observed correlation between gas content and Hubble type. (auth)

48728 MODELS FOR OH RADIATION FROM THE INTERSTELLAR MEDIUM. Peters, G. I.; Allen, L. (Univ. of Sussex, Brighton, Eng.). Astrophys. J.; 176: No. 1, L23-5(15 Aug 1972).

Some recently proposed models for OH radiation from the interstellar medium are shown to be in error. A theory for radiation from an inverted medium amplifying both its own spontaneous emission and an external signal allows comment to be made on the possible emission mechanisms occurring in the medium. (auth)

48729 OSCILLATOR STRENGTHS OF THE SO $A\,^3\Pi$-$X\,^3\Sigma^-$ BAND SYSTEMS. Smith, William Hayden (Princeton Univ., N. J.). Astrophys. J.; 176: No. 1, 265-5(15 Aug 1972).

The oscillator strengths for the SO $A\,^3\Pi - X\,^3\Sigma^-$ band systems were calculated using RKR Franck–Condon factors and the radiative lifetime previously derived from electron-beam phase-shift measurements. (auth)

48730 INFALL OF MATTER INTO CLUSTERS OF GALAXIES AND SOME EFFECTS ON THEIR EVOLUTION. Gunn, James E. (California Inst. of Tech., Pasadena. Carnegie Institution of Washington, D. C.); Gott III, J. Richard. Astrophys. J.; 176: No. 1, 1-19(15 Aug 1972).

A theory of infall of material into clusters of galaxies is developed and applied to the Coma cluster. It is suggested that the infall phenomenon is responsible for the growth of cluster galaxies. The generation of a hot intracluster medium is discussed and its relation to the observed absence of normal spirals in rich clusters investigated. The inference made earlier by Gott and Gunn that the observed x-ray luminosity of Coma puts severe constraints on the deceleration parameter q_0 is further elucidated. The relation of these phenomena to the morphology of clusters is discussed, and it is found that some observed regularities in their observed properties can be explained. (auth)

48731 ABSOLUTE MAGNITUDES OF E AND S0 GALAXIES IN THE VIRGO AND COMA CLUSTERS AS A FUNCTION OF U–B COLOR. Sandage, Allan (Hale Observatories, Pasadena, Calif.). Astrophys. J.; 176: No. 1, 21-30(15 Aug 1972).

Three-color photoelectric data are listed for 25 galaxies in the Coma cluster and six faint dwarf ellipticals in the Virgo cluster. The correlation between stardard isophotal apparent magnitude of the galaxies and their U–B values has a correlation coefficient of $r = 0.94$, and extends over 8.5 magnitudes. The rms deviation of the U–B correlation gives $\sigma(\Delta V_{26}) = 0.72$ mag, excluding the two largest residuals. K-corrections are computed and listed for U–B and Q indices for $z \lesssim 0.03$. Applying the corrections to the Coma cluster permits the color–magnitude effect in Coma and Virgo to be compared, so as to test the zero-point difference between the clusters. The least-squares magnitude shift between Coma and Virgo is $\Delta V_{26} = 3.66 \pm 0.14$ mag from the color–magnitude effect, agreeing with $\Delta V_{26} = 3.84$ (+0.42, –0.36) required by the ratio of the redshifts, if there is no local shear to the velocity field at Virgo. The present data are inconsistent with the Abell and Eastmond hypothesis of fitting humps in the luminosity function that requires $\Delta V = 4.7$ mag. The need for a second parameter in the $M_V = f(U-B)$ relation is uncertain. The color–magnitude relation is expected to be useful in estimating relative distances to field E and SO galaxies on the scale of the distance to the Coma cluster. (auth)

48732 ACTIVITY IN GALAXIES AND QUASARS. Sturrock, P. A.; Barnes, C. (Stanford Univ., Calif.). Astrophys. J.; 176: No. 1, 31-45(15 Aug 1972).

Activity in galaxies and quasars is interpreted in terms of plasma processes occurring in the magnetosphere of a certain magnetoid model. This magnetoid comprises a core and an annulus rotating about a common axis with different angular velocities. The magnetic field linking the core to the annulus may begin in an initial current-free state but will be distorted along a sequence of force-free configurations. After a finite differential rotation, the force-free configuration has higher energy than a corresponding open-field configuration. It is conjectured that the transition from the closed configuration to an open configuration will be effected by an MHD "eruptive" instability, and that such eruptions lead to high-velocity clouds of cool gas identified with clouds producing absorption lines in quasars. The open magnetic-field configuration necessarily contains current sheets. The magnetic free energy of these current sheets may be released explosively by the flare mechanism. The ejection of radio clouds from galaxies and quasars is attributed to "galactic flares." Current sheets contain mildly relativistic electrons moving in directions partially transverse to the magnetic field. Synchrotron radiation from these electrons is held to be responsible for the nonthermal radiation from quasars and certain galaxies. It is proposed that minor instabilities of the current sheets are responsible for fluctuations in the nonthermal luminosity and for small-scale radio bursts sometimes observed in galaxies and quasars. (auth)

48733 DISTRIBUTION OF LINEAR POLARIZATION IN 3C 270 AND 3C 452 AT 21-CENTIMETER WAVELENGTH. Kronberg, P. P. (Univ. of Toronto). Astrophys. J.; 176: No. 1, 47-55(15 Aug 1972).

Two-dimensional radio distributions for 3C 452 and 3C 270 (NGC 4261) are obtained with a resolution of approximately 1′ arc for both the total radiation and the linearly polarized component at λ21.1 cm. The results are compared with existing data at other wavelengths, and some physical parameters for both sources are estimated. The results for 3C 270 show that the projected magnetic field is perpendicular to the source's direction of elongation, and that in some portions it is very highly ordered. (auth)

48734 LINEAR POLARIZATION OF THE Hα EMISSION LINE IN THE HALO OF M82 AND THE RADIATION MECHANISM OF THE FILAMENTS. Visvanathan, N.; Sandage, Allan (Hale Observatories, Pasadena, Calif.). Astrophys. J.; 176: No. 1, 57-74(15 (15 Aug 1972).

New polarization measurements have been made of five faint outer regions in the M82 halo to test if the electric vectors are perpendicular to the filaments, or to the radius vector from the center. The measurements agree to within 2 σ with a scattering model, but differ by 4 to 9 σ from the prediction for the synchrotron mechanism. (W.D.M.)

48735 OPTICAL SPECTRUM OF THE SEYFERT GALAXY 3C 120. Shields, G. A.; Oke, J. B.; Sargent, W. L. W. (Hale Observatories, Pasadena, Calif.). Astrophys. J.; 176: No. 1, 75-89(15 Aug 1972).

The spectrum of the nucleus of the Seyfert galaxy 3C 120 was studied with the aid of spectrophotometric scans and photographic spectrograms. The scans cover the wavelength range λλ3330 to 10620, and the spectrograms cover the wavelength range λλ3200 to 6900. These data have been used to study the emission lines and the optical continuum of 3C 120. It is shown that the emission lines are heavily reddened, and $A_V = 0.78$ mag on the assumption that the Whitford law is applicable. Two regions appear to produce the emission lines in 3C 120. The region producing the forbidden lines (which have half-widths of about 300 km s^{-1}) has $N_e \sim 10^3$ cm^{-3}, $T_e \sim 2 \times 10^4$°K, and a mass of about 10^4 to 10^5 $M_\odot$. The region which produces the broader, permitted lines (half-widths of several thousand km s^{-1}) has $T_e \sim 6000$°K, $N_e \gtrsim 10^8$ cm^{-3}, and a mass $\lesssim 200$ $M_\odot$. It is argued that this material is in the form of clouds or filaments which may be immersed in the forbidden-line region. This is in contrast to the single, compact cloud proposed in electron-scattering models for the line broadening. A third region is responsible for the largely nonthermal continuum. The spectrum of 3C 120 contains strong He I and He II emission lines; it is pointed out that these do not necessarily imply an abnormally large helium abundance. The scanner observations covered a period of 3 years, and during that time the continuum varied by 20%, while the emission lines did not vary in a detectable manner. (auth)

48736 NEW DETERMINATION OF THE MASS OF M32. Richstone. Douglas; Sargent, Wallace L. W. (Hale Observatories, Pasadena, Calif.). Astrophys. J.; 176: No. 1, 91-8(15 Aug 1972).

The radial-velocity dispersion of the stars in the nucleus of M32 was determined from two Palomar coudé spectra, dispersion 18 Å mm^{-1}, to be $\sigma_r = 60 \pm 8$ km s^{-1}. This estimate was obtained by comparing the M32 spectra with spectra of δ Tau (K0 III) which were digitally convolved with a Gaussian function representing the dispersion in velocity. This value of σ_r is smaller than the values ($\sigma_r \sim 100$ km s^{-1}) obtained by Minkowski and by Burbidge, Burbidge, and Fish; possible reasons for the discrepancy are discussed. The mass of M32 calculated from the derived values of σ_r is $1.30 \pm 0.50 \times 10^9$ $M_\odot$, and the mass-to-light ratio is $M/L_p = 6.9 \pm 2.2$; these are also smaller than previous values. (auth)

Cosmology

Refer also to abstracts 49114, 49174, 49178, 49191, 49194, and 49203.

48737 SURVEY OF THE UNIVERSE. Menzel, Donald H.; Whipple, Fred L.; De Vaucouleurs, Gerard. Englewood Cliffs, N. J.; Prentice-Hall, Inc. (1970). 877p. $16.50.

Topics covered include results of U. S. space program including exploration of the Moon, Sun, and Mars; quasars and pulsars; developments in radio, x-ray, and γ-ray astronomy; exobiology; rocketry; nucleosynthesis; and extragalactic astronomy including exploding nuclei and large-scale clustering of galaxies. (W.D.M.)

48738 CRITERIA OF COSMOLOGICAL SPATIAL HOMOGENEITY. MacCallum, M. A. H. (King's Coll., Cambridge, Eng.). Phys. Lett.; 40A: No. 4, 325-6(31 Jul 1972).

Grishchuk's recent discussion of two definitions of spatial homogeneity and their Newtonian counterparts is reviewed and an alternative presented. (auth)

48739 STATIC BLACK HOLES IN BRANS–DICKE THEORY ARE SCHWARZSCHILD. Johnson, M. (Univ. of Alberta, Edmonton). Lett. Nuovo Cim.; 4: No. 8, 323-7(24 Jun 1972).

Israel's (1967) theorem concerning the uniqueness of the exterior vacuum field of a static black hole of mass m is extended to the Brans–Dicke theory. If the scalar field φ is assumed to tend to 1 at infinity and to remain bounded on the horizon, then φ is identically 1 and the field becomes the Schwarzschild solution. (W.D.M.)

48740 GRAVITATIONAL WAVES COME DOWN TO EARTH. Mitton, S. New Sci.; 55: No. 805, 132-4(20 Jul 1972).

Gravitational wave experiments are amongst the latest trends in speculative physics experiments. Several groups throughout the world are searching for astrophysical sources of gravitational radiation. A group in Israel may have detected a nearby pulsar with a sensitive seismometer, and in Britain apparatus which could detect the radiation is under construction at three universities. (auth)

48741 DIAGONAL BIANCHI COSMOLOGIES. MacCallum, M. A. H. (King's Coll., Cambridge, Eng.). Phys. Lett.; 40A: No. 5, 385-6(14 Aug 1972).

A list of the possible "diagonal" Bianchi cosmologies is given, with a proof that it is complete. (auth)

48742 COSMOLOGICAL EQUATIONS IN A UNIVERSE WITH SMALL SCALE CONDENSATIONS. Nelson, A. H. (Nagoya Univ., Japan). Mon. Notic. Roy. Astron. Soc.; 158: No. 2, 159-75(Jul 1972).

The metric describing a Universe containing small-scale condensations is divided into two terms. One term represents the large scale, global development of space-time, while the other represents the small scale effects of local condensations. The global term is approximated by an average of the metric over a region containing many condensations. Equations to be satisfied by the individual terms of the metric are then derived from a combination of the Einstein equations and the averaged Einstein equations. The average of the metric is shown to satisfy the usual set of cosmological equations for a "smeared out" metric, to a high degree of approximation; while the difference between the metric and its average satisfies a separate set of equations equivalent to instability equations. The large scale development of such a Universe is therefore shown to be almost independent of the formation of condensations provided the average of the energy—stress tensor is unaffected by the condensations. (auth)

48743 UNIFORM TRANSPARENT GRAVITATIONAL LENS. Clark, E. E. (King's Coll., London). Mon. Notic. Roy. Astron. Soc.; 158: No. 2, 233-43(Jul 1972).

An elementary discussion is given of the gravitational deflection of light due to radially and cylindrically symmetric masses. The effect of the deflection on apparent luminosity of distant sources is also considered. All results are limited to weak, static, asymptotically flat gravitational fields. Emphasis here is on observations of sources aligned behind the disc of the deflecting mass so that the possible transparency of this mass is decisive in image formation. Detailed calculations are made for the simple case of the uniformly dense transparent sphere and comparisons are made with the opaque mass sphere. If they have the same mass and radius, the maximum light deflection produced by these lenses is nearly equal. However, their effects on the area of narrow light beams may be quite different. The uniform transparent sphere does not produce multiple images of one source and, to first order, introduce no image distortion. (auth)

48744 RADIATION PRESSURE ON DUST IN GENERAL RELATIVITY. Bondi, H. (Ministry of Defence, London). Nature (London) Phys. Sci.; 238: No. 82, 58-9(24 Jul 1972).

The equilibrium is discussed of a spherically symmetric system in which a radiating body is surrounded at some distance by a zone of absorbing dust. (UK)

48745 OBSERVATION OF FLUCTUATIONS OF RELICT RADIO EMISSION AS A METHOD OF DISTINGUISHING ADIABATIC FROM OTHER FORMS OF DISTURBANCES IN THE DENSITY OF MATTER IN THE UNIVERSE LEADING TO GALAXY FORMATION. Zel'dovich, Ya. B.; Rakhmatulina, A. Kh.; Syunyaev, R. A. (Inst. of Applied Mathematics, Moscow). Izv. Vyssh. Ucheb. Zaved., Radiofiz.; 15: No. 2, 161-71(1972). (In Russian).

A peculiar periodic dependence of the amplitude on the mass is typical of adiabatic density perturbations. A detailed investigation of the relict radiation fluctuations may lead to clarifying the nature of primary density perturbations with which is associated the formation of galaxies and clusters of galaxies. (auth)

48746 COSMOLOGICAL MODELS WITH NON-ZERO PRESSURE. Kulhanek, J.; Szamosi, G. (Univ. of Windsor, Ont.). pp 221-4 of Relativity and Gravitation. /Kuper, Charles G. (ed.). New York; Gordon and Breach, Science Publishers, Inc. (1971).

From Seminar on relativity and gravitation; Haifa, Israel (15 Jul 1969). See CONF-690713.

Relativistic cosmological models are constructed which are very similar to the Friedman model and which allow nonzero pressure. (J.F.P.)

48747 SOME NOTES ON COSMOLOGY. Pachner, J. (Univ. of Alberta, Edmonton). pp 265-8 of Relativity and Gravitation. /Kuper, Charles G. (ed.). New York; Gordon and Breach, Science Publishers, Inc. (1971).

From Seminar on relativity and gravitation; Haifa, Israel (15 Jul 1969). See CONF-690713.

Some principles on which scientific cosmology should be based in its further development are given. The starting point of the discussion is the assumption that the decisive phenomenon in cosmic evolution is gravitation and possibly some other cosmic field. General relativistic theory is considered. (J.F.P.)

48748 RECENT RENAISSANCE OF OBSERVATIONAL COSMOLOGY. Sciama, D. W. (Cambridge Univ., Eng.). pp 283-304 of Relativity and Gravitation. /Kuper, Charles G. (ed.). New York; Gordon and Breach, Science Publishers, Inc. (1971).

From Seminar on relativity and gravitation; Haifa, Israel (15 Jul 1969). See CONF-690713.

The detection of objects with extremely large redshifts and the discovery of the cosmic blackbody radiation have led to a great renaissance in observational cosmology. Developments arising from these discoveries are discussed, including the radio source counts, quasar counts, the intergalactic medium, and cosmic blackbody radiation. (W.D.M.)

48749 OBSERVATIONAL EVIDENCE AGAINST SUPERNOVAE BEING THE SOURCE OF THE UNIVERSAL X-RAY BACKGROUND. Mack, John E. (Univ. of Houston, Tex.); Robbins, Donald E. Astrophys. J.; 176: No. 1, 99-101(15 Aug 1972).

An analysis was made of the theory that the universal x-ray background originates in supernovae. Observational evidence relating to such theories was critically examined. It was concluded that evidence presently exists which can be interpreted to exclude such theories of the origin of the background radiation, regardless of the timescale of the x-ray emission from a supernova. (auth)

Planetary Phenomena

48750 STUDY OF A JOVIAN PLASMASPHERE AND THE OCCURRENCE OF JUPITER RADIOBURSTS. Conseil, L. (Observatoire de Paris, Meudon). Leblanc, Y.; Antonini, G.; Quemada, D. pp 27-35 of Cosmic Plasma Physics. /Schindler, Karl (ed.). New York, Plenum Publishing Corp. (1972).

From Conference on cosmic plasma physics; Frascati, Italy (20 Sep 1971). See CONF-710951.

Data were analyzed of Jupiter decametric emission and solar wind observations during the period of Aug. 1, 1964 to Nov. 30, 1964 and Nov, 15, 1967 to Mar. 30, 1968. A close relationship is exhibited between the solar wind velocity and the phase of Io during Jupiter radio bursts. This is interpreted by the existence of a plasmasphere around Jupiter; the emission should be stimulated when the satellite Io crosses the plasmapause which is very sensitive to the solar wind velocity variations. The boundary of the plasmasphere was calculated from the interaction of the corotating electric field of Jupiter and the convective field induced by the solar wind inside the magnetosphere of the planet, then the motion of the spatial configuration of the Jovian plasmapause is derived by introducing a positive and a negative rate of change of the solar wind velocity. (auth)

48751 SIMPLE EARTH MODEL. Wang, Chi-yuen (Univ. of California, Berkeley). J. Geophys. Res.; 77: No. 23, 4318-29(10 Aug 1972).

A simple Earth model consistent with the current physical and petrological theories of the mantle is constructed. The density of different layers is estimated in different ways, depending on the relative reliability in the seismic velocities in the layers. In the upper mantle, where the representative seismic velocities are somewhat uncertain, velocities and density are calculated from a petrological model; D. H. Green and A. E. Ringwood's (1967) model is taken as a convenient starting point. In the transition zone where V_P alone is reliable, Birch's empirical relation between V_P and density is used to estimate density. In the lower mantle where both V_P and V_S are reliable, an empirical relation between the bulk sound velocity and density is used to estimate density. Adams and Williamson's relation is used in the core. The various properties of this model, such as mass, moment of inertia, travel times, periods of free oscillations, and velocities of the surface waves, are calculated and compared with the observations. With the provision of a low-velocity zone in the upper mantle, this model satisfies the observations within the widely accepted uncertainties. (auth)

PHYSICS (ATMOSPHERIC)

Auroral and Ionospheric Phenomena

Refer also to abstract 49635.

48752 (AD–734390) ELECTRON-PRODUCTION RATE OF SOLAR AND GALACTIC COSMIC RAYS IN THE LOWER IONOSPHERIC D-REGION. Research and Development Report, August 1969–June 1970. Argo, Paul E. (Naval Electronics Lab. Center, San Diego, Calif.). 11 Aug 1971. 30p. (NELC-TR–1783). NTIS.

The heavy-ion component of galactic cosmic rays is found to yield an electron-production rate approximately one-half the magnitude of the proton component. At high altitudes, variations in the cutoff energy level in the middle and high geomagnetic latitudes (physically caused by geomagnetic storms) have a large effect on the electron-production rate of galactic cosmic rays (especially in the transition region between cutoff and no effective cutoff (~68°)); in the 30-to-60-km altitude region, however, electron production is not significantly affected. Solar protons can cause an abnormally high electron-production rate (at high latitudes) to all depths of the ionosphere, indicating a large effect on vlf reflection during solar-particle storms. (auth) (NTIS)

48753 (AWRE-O–34/72) TWO-DIMENSIONAL RAY-TRACING PROGRAM. Curtis, A. R. (Atomic Weapons Research Establishment, Aldermaston (England)). May 1972. 154p. Dep. NTIS (U. S. Sales Only). UK 1.00 pound.

The digital-computer program described is written in FORTRAN IV for the IBM 7030 (Stretch) computer for tracing the paths of high-frequency electromagnetic rays through two-dimensional models of the ionosphere, omitting the effects of the geomagnetic field and electron collisions from the evaluation of refractive index. The program also computes phase and group-path data and absorption along the rays, and signal-strength calculations are available as an option. A variety of outputs are obtainable in the form of printed tables, punched cards and ray-path plots. Each component of the program is briefly described, and FORTRAN listings and definitions of variables are provided. Examples of ionospheric models are given and the report indicates how alternative models may be written into the program. (auth)

48754 (EGG–1183-5006) GEOMETRIC AND RADIOMETRIC DATA REDUCTION FOR SECEDE II EVENTS, PLUM AND SPRUCE. Breedlove, J. R. Jr.; Marram, E. P. (EG and G, Inc., Los Alamos, N. Mex.). 1 Dec 1971. Contract AT(29-1)-1183. 49p. Dep. NTIS.

For Los Alamos Scientific Lab., N. Mex.

The results of data reduction of photographic records obtained for the PLUM and SPRUCE events conducted in January 1971 were given. The evolution of the PLUM and SPRUCE barium clouds as viewed along a direction parallel to the geomagnetic field are compared. Cloud dimensions, velocities, and ion cloud radiance are presented. Bounds on ion column densities for both events and estimates of ion inventories for SPRUCE are given. Both PLUM and SPRUCE developed in basically the same way although interesting differences in detailed structure and time scales are noted. For example, PLUM develops much more quickly than SPRUCE. Although an estimate of the SPRUCE ion inventory of 4.7×10^{24} was obtained by extending the optical power versus time curve beyond the time of sunset, conclusions from the radiometric analysis were limited by the fact that for most times the ion cloud was optically thick at 4554 Å. At times after structure formed in the ion clouds, there was no conclusive evidence in the isoradiance contours that the fingers of ionization, which extended in the direction of the neutral wind, were end-on views of rods aligned along our line of sight. A study of the position of the magnetic zenith showed that the cameras were looking up the tangent to the field lines much of the time. The average angles between the magnetic-field vector at the cloud and the cloud-camera line were found to be 1.68° (variance = 0.59 deg^2) for PLUM and 1.43° (variance + 0.47 deg^2) for SPRUCE. (auth)

48755 (N–72-21354) DAYSIDE AURORAL OVAL PLASMA DENSITY AND CONDUCTIVITY ENHANCEMENTS DUE TO MAGNETOSHEATH ELECTRON PRECIPITATION. Kennel, C. F.; Rees, M. H. (California Univ., Los Angeles. Dept. of Physics). Sep 1971. Contract AT(04-3)-34. 19p. (NASA-CR–125929; PPG–96). NTIS.

By assuming that magnetosheath electrons are maintained as isotropic by strong pitch-angle diffusion as they precipitate into the ionosphere, the precipitation heat flux may be simply related to solar wind energy density, and consequently to the level of magnetic activity. For quiet solar wind conditions, the 1 to 10 erg/cm^2 · sec heat fluxes expected and observed lead to height-integrated Pedersen conductivity enhancements of 4 to 15 mhos. During magnetic storms, the conductivity enhancements could increase by a factor of 3 to 5. Since the precipitating electrons are soft, the Hall conductivity enhancements are smaller. Nevertheless, they lead to field-aligned currents bounding the oval in agreement with observations. (auth) (STAR)

48756 (N–72-21361) PARTIAL REFLECTIONS OF RADIO WAVES FROM THE LOWER IONOSPHERE. Connolly, Denis J.; Tanenbaum, Samuel B. (National Aeronautics and Space Administration, Cleveland, Ohio. Lewis Research Center). Apr 1972. 50p. (NASA-TN-D–6742; E–6701). NTIS.

The addition of phase-difference measurements to partial-reflection experiments is discussed, and some advantages of measuring electron density this way are pointed out. The additional information obtained reduces the requirement for an accurate predetermination of collision frequency. Calculations are also made to estimate the errors expected in partial-reflection experiments due to the assumption of Fresnel reflection and to the neglect of coupling between modes. In both cases, the errors are found to be of the same order as known errors in the measurements due to current instrumental limitations. (STAR)

48757 (SC-RR–720111) NUMERICAL SOLUTION OF THE TWO-DIMENSIONAL FLUSH-MOUNTED ELECTROSTATIC PROBE PROBLEM. Russo, A. J. (Sandia Labs., Albuquerque, N. Mex.). Jul 1972. 41p. Dep. NTIS.

The charged-particle number densities and the electric potential in a region surrounding a two-dimensional flush-mounted electrostatic probe are calculated by solution of an elliptic set of equations. The method of solution and the results of some studies in which probe voltage, probe size, transport properties, ion—electron temperature ratio, and flow velocity were varied are discussed. (auth)

48758 METHOD FOR DETERMINING THE ELECTRON DENSITY DISTRIBUTION ABOUT THE F_2 PEAK OF THE IONOSPHERE. Dyson, P. L. (La Trobe Univ., Bundoora, Australia). Aust. J. Phys.; 25: No. 3, 293-7(Jun 1972).

A method is given for extending the analysis of topside ionograms to yield ionospheric electron-density profiles down to and below h_{max}, the peak of the F2 layer, by analysis of the ground echoes. Calculations using model ionospheres indicate that the accuracy of the method is not seriously affected by the assumptions made or by the limited accuracy with which ionograms can be scaled. (auth)

48759 MODEL IONOSPHERE FOR D REGION AT SUMMER NOON DURING SUNSPOT MAXIMUM. Bain, W. C. (Radio and Space Research Station, Slough, Eng.); Harrison, Marilyn D. Proc. Inst. Elec. Eng. (London); 119: No. 7, 790-6(Jul 1972).

A model ionosphere, comprising electron-density and collision-frequency distributions for the midlatitude D region at summer noon during sunspot-maximum conditions, was produced that gives satisfactory results for propagation at low and very low-frequencies. The electron-density distribution above 68 km was based on a distribution, measured in a rocket, which was altered untill full-wave calculations using it gave propagation parameters in agreement with the average observed values. Below 68 km, a C layer was found necessary to give the best fit to measured ground-interference patterns at 16 kHz. A comparison is also shown between a measured pattern of this kind and one calculated from the rocket distribution, which was obtained on the same day. (auth)

48760 APPEARANCE OF PARTICLES IN THE UPPER ATMOSPHERE AT MODERATE LATITUDES. Gogoshev, M. M. (Astronomical Observatory, Stara Zagora, Bulgaria). Compt. Rend. Acad. Bulg. Sci.; 25: No. 1, 31-3(1972). (In Russian).

Some preliminary results are reported of nocturnal photometric observations of N_2^+ particles made at the north geomagnetic latitude of 40.2° from May to December, 1970 (28 nights total). Twilight effects were not noted. The upper limit of the constant "background" electron flux was related to the magnetically still night in the ionosphere. The combined emissions of the nocturnal sky and the Earth's magnetism suggest a possibility of detecting the appearance of particles with kilovolt energies in the upper atmosphere at middle latitudes. (K.S.W.)

48761 DETERMINING THE EQUIVALENT DELAY FROM THE REGIONS BELOW f_{min} UPON CALCULATING N(h) PRO-

FILES. Koutiev, I. S. (Inst. of Geophysics, Sofia). Compt. Rend. Acad. Bulg. Sci.; 25: No. 2, 193-6(1972).

The methods for calculating N(h) profiles were discussed. An approach for solving the problem, which gives the equivalent delay caused by the ionization below f_{min} and, at the same time, also the integral ionization below the level $h(f_{min})$ is presented. The present method may also be applied in the case of an extremum distribution of the electron concentration in the E region, when under day conditions there is a signal reflected from this layer. The present method uses a physical property of the radio waves that spread in an ionized medium. One and the same electron concentration has the same influence on the dissemination rate of the radio waves sounding the ionosphere. The average effect of the delay caused by uniform density of electron concentration limited in a height interval is searched for. This method, without giving the distribution in the unsoundable region of the ionosphere, restores the exact distribution at those points in which there exists reflection of the ionogram. (J.C.W.)

48762 MUTUAL RELATIONS BETWEEN LINE 6300 A AIRGLOW AND REGION F PARAMETERS. Serafimov, K. B.; Gogoshev, M. M. (Geophysical Inst., Sofia). Compt. Rend. Acad. Bulg. Sci.; 25: No. 2, 197-200(1972).

The possible sources of the main part of the natural optical emission in the night sky with a 6300-A wavelength are: the dissociative recombination of the molecular oxygen ions and the nitrogen oxide ions in the F region; the resonance excitation of solar irradiation at 6300 A; the dissociation of the oxygen molecules under the action of diffused solar radiation in the region of the Schumann—Runge band and the impact of sufficiently energetic corpuscles of solar or terrestrial origin. Among these sources, under normal conditions, the radiation of the oxygen atoms in a ^1D state, excited during dissociative recombination, has a higher intensity. Only in the case of disturbances or anomalies do the other sources of emission 6300 A have a comparable or stronger influence. The relation between the irradiation of 6300 A and the F-region parameters in the night atmosphere is deduced from an expression showing a semi-empirical dependence. (J.C.W.)

48763 FLUX VARIATIONS OF CHARGED PARTICLES OF DIFFERENT ENERGIES FROM DATA OF VARIOUS SPACE PROBES. Vernov, S. N.; Gorchākov, E. V.; Ignat'ev, P. P.; Galach'ev, N. G. Izv. Akad. Nauk SSSR, Ser. Fiz.; 35: No. 12, 2418-22(Dec 1971). (In Russian).

Proton data from six space stations were used to summarize information on variations in charged-particle fluxes in 1965, 1967, and 1969. Interest was centered particularly on proton energies with E = 1 to 5 MeV, and E > 30 MeV. Variations in intensity of the galactic cosmic rays in the interval 1965—1969 indicated a change in the conditions of propagation and possibly in generation of charged particles in the solar system. With an increase in solar activity, however, the background of protons with E = 1 to 5 MeV decreased. (K.S.W.)

48764 EXCESS RADIATION AT ALTITUDES OF 200 TO 500 km. Konyakhina, S. S.; Kurnosova, L. V.; Logachev, V. I.; (and others) (Lebedev Inst. of Physics, Moscow. Inst. of Terrestrial Magnetism, Ionosphere, and Radio-Wave Propagation, Moscow). Izv. Akad. Nauk SSSR, Ser. Fiz.; 35: No. 12, 2472-5(Dec 1971). (In Russian).

The discovery of a radiation background at 200 to 300 km that, at equatorial latitudes, was 5 to 10 times higher than the cosmic-ray intensity leads to a comparison of the pertinent data with the results of other workers. The energy spectra of electrons were contrasted in such a manner that light bursts of various magnitudes were compared with isolated electrons, wherein the total amplitude of bursts in three scintillators was associated with electron energies. The altitude dependence of events recorded by three telescopes in the equatorial region indicated that an excessive background of charged particles, recorded at heights of 250 to 500 km, increased somewhat with altitude. (K.S.W.)

48765 HIGH-ENERGY ELECTRONS AND γ QUANTA IN THE UPPER LAYERS OF THE ATMOSPHERE. Gal'per, A. M.; Dmitrenko, V. V.; Kirillov-Ugryumov, V. G.; (and others). Izv. Akad. Nauk SSSR, Ser. Fiz.; 35: No. 12, 2476-8(Dec 1971). (In Russian).

Previous studies by the same authors of 100 to 1,500 MeV electrons by means of altitude aerostats were extended, and the intensity-time relations of the electron flux at the limit of the atmosphere were investigated. Similar measurements were made on γ quanta and transient particles (i.e., particles that produced a single straight trace in the spark chamber). Such fluxes were separately determined for electrons possessing energies in the interval 100 to 1,500 MeV and γ quanta in the interval 100 to 500 (and $\gtrsim 500$) MeV. (K.S.W.)

48766 ELEVEN-YEAR SOLAR MODULATION OF COSMIC-RAY INTENSITY IN THE STRATOSPHERE. Bazilevskaya, G. A.; Kvashnin, A. N.; Pankratov, A. K.; (and others) (Lebedev Inst. of Physics, Moscow. Moscow State Univ.). Izv. Akad. Nauk SSSR, Ser. Fiz.; 35: No. 12, 2483-7(Dec 1971). (In Russian).

The temporal course of cosmic-ray intensity in the stratosphere, N_m, bears a relation to the solar activity that may be expressed by $\ln(N_m^0/N_m) \approx \eta^{0,8}\bar{\varphi}^{-1,2}$, where η is the number of spot groups, $\bar{\varphi}$ is the average width of spot formation on the Sun, and N_m^0 is the maximum value of N_m (from April to May, 1965). An insignificant deviation from this relation was observed in periods of maximum solar activity, and derives from a Forbush decrease. (tr-auth)

48767 ENERGY SPECTRUM OF EPITHERMAL NEUTRONS IN THE ATMOSPHERE. Abdurakhmanov, A. Kh.; Efimov, Yu. E.; Romanov, A. M.; Stepanova, E. G.; Chichikalyuk, Yu. A. (Ioffe Inst. of Physics and Tech., Leningrad). Izv. Akad. Nauk SSSR, Ser. Fiz.; 35: No. 12, 2547-9(Dec 1971). (In Russian).

The spectrum of epithermal neutrons in atmospheric layers at equilibrium was investigated in 1967—69. The differential flux of epithermal neutrons is approximated by the expression $F(E) = F_0E^{-\alpha}$, where $\alpha \approx 1$. The procedure for calibrating the detectors used is given. (tr-auth)

48768 SHORT-PERIOD INTENSITY PULSATIONS OF COSMIC RAYS IN THE STRATOSPHERE. Bazilevskaya, G. A.; Krasotkin, A. F.; Okhlopkov, V. P.; Charakhch'yan, A. N.; Charakhch'yan, T. N. (Inst. of Physics, Moscow. Moscow State Univ.). Izv. Akad. Nauk SSSR, Ser. Fiz.; 35: No. 12, 2550-5 (Dec 1971). (In Russian).

Short-period variations of cosmic-ray intensity in the stratosphere at altitudes ~30 km in the frequency region of 0.05 to 25 cycles/min were investigated. A quasi-periodic variation with a period of 4.2 min and an amplitude of 1.3% was detected, persisting for about 40 min. (tr-auth)

48769 THEORY OF METEOROLOGICAL EFFECTS OF COSMIC RAYS. I. A DEDUCTION OF GENERAL FORMULAS FOR INTENSITY AND METEOROLOGICAL COEFFICIENTS AND CALCULATION PROCEDURE. Dorman, L. I.; Yanke, V. G. Izv. Akad. Nauk SSSR, Ser. Fiz.; 35: No. 12, 2556-70 (Dec 1971). (In Russian).

The theory of meteorological effects on the intensity of hard muons is developed. The muon generation spectrum is calculated for the decay of pions, actual temperature distribution in the atmosphere, etc. The results are compared with experimental data on the path height, angular distribution, and energy spectrum of muons. Numerical values of the parameters are chosen, based on such a comparison. Coefficients are calculated and depicted graphically. (tr-auth)

48770 THEORY OF METEOROLOGICAL EFFECTS OF COSMIC RAYS. II. FORMULAS FOR CALCULATION. Dorman, L. I.; Yanke, V. G. Izv. Akad. Nauk SSSR, Ser. Fiz.; 35: No. 12, 2571-82(Dec 1971). (In Russian).

The use of an electronic computer made it possible to consider the spectrum and angular distribution of muons during pion decay and the Coulombic scattering of muons. The results of calculation of barometric coefficients and of the density of temperature coefficients of soft muons are graphically depicted. (tr-auth)

48771 OPTIMUM MODEL OF THE GEOMAGNETIC FIELD. Kolesova, V. I.; Kropachev, E. P.; Tyasto, M. I. (Inst. of Terrestrial Magnetism, Ionosphere, and Radio-Wave Propagation, Leningrad). Izv. Akad. Nauk SSSR, Ser. Fiz.; 35: No. 12, 2587-92(Dec 1971). (In Russian).

The magnitude of spherical, harmonic coefficients calculated by using least squares, depends essentially on the length of the series. The main magnetic field may be described by a series expansion to n = 25. A modification of the integral method of spherical harmonic analysis is briefly described, from which the coefficients g_n^m and h_n^m may be computed to n = 23, allowing for the nonsphericity of the Earth. The coefficients up to n = 11 are tabulated. (tr-auth)

48772 MAGNETOSPHERIC SUBSTORMS. Coroniti, F. V.; Kennel, C. F. (Univ. of California, Los Angeles). pp 15–23 of Cosmic Plasma Physics. /Schindler, Karl (ed.). New York, Plenum Publishing Corp. (1972).

From Conference on cosmic plasma physics; Frascati, Italy (20 Sep 1971). See CONF-710951.

A model of a substorm growth phase is presented, which logically proceeds from a time-dependent convective flow. (M.O.W.)

48773 PARAMETRIC INSTABILITIES GENERATED IN THE IONOSPHERE BY INTENSE RADIO WAVES. Oberman, C.; Perkins, F.; Valeo, E. (Princeton Univ., N. J.). pp 25-6 of Cosmic Plasma Physics. /Schindler, Karl (ed.). New York, Plenum Publishing Corp. (1972).

From Conference on cosmic plasma physics; Frascati, Italy (20 Sep 1971). See CONF-710951.

There is mounting evidence that the ionospheric heating experiments being conducted at Boulder and Arecibo cause parametric instabilities—in agreement with the theoretical prediction (F. W. Perkins and P. K. Kaw, J. Geophys. Res., 76: 282(1971)) that their electric fields exceed the threshold for parametric instabilities. The nonlinear saturation level of these instabilities is computed, and the results are compared with experimental measurements. In particular, the Thomson scatter measurements offer a unique opportunity to perform steady-state experiments on nonlinear plasma physics. (auth)

48774 EFFECT OF A LARGE-AMPLITUDE WAVE PACKET AND SECOND-ORDER RESONANCE ON THE STIMULATION OF VLF EMISSIONS. Das, A. C. (Physical Research Lab., Ahmedabad, India). pp 37-44 of Cosmic Plasma Physics. /Schindler, Karl (ed.). New York, Plenum Publishing Corp. (1972).

From Conference on cosmic plasma physics; Frascati, Italy (20 Sep 1971). See CONF-710951.

The effect of wave-particle interactions for a large amplitude whistler-mode wave packet was included in a model for vlf emissions. The resonant particles will be redistributed after a whistler mode wave packet has passed, and the growth rate which depends on the distribution function is computed for the disturbed distribution. The nature of the growth rate remains more or less same as that for the case of a small amplitude wave packet while the peaks in the growth rate which occur at frequencies slightly above and below the central frequency are further enhanced by a considerable amount. These enhancements then give enough amplification for vlf emissions to be seen and may also explain some of the duplicate traces in the whistler mode observed at low latitude. (M.O.W.)

48775 UNIVERSAL INSTABILITY ASSOCIATED WITH THE PLASMAPAUSE AND ITS ROLE IN GEOMAGNETIC MICROPULSATIONS. Kikuchi, H. (Goddard Space Flight Center, Greenbelt, Md.). pp 45-54 of Cosmic Plasma Physics. /Schindler, Karl (ed.). New York, Plenum Publishing Corp. (1972).

From Conference on cosmic plasma physics; Frascati, Italy (20 Sep 1971). See CONF-710951.

A steep plasma density gradient at the plasmapause is likely to be an origin of the "universal" instability in the magnetosphere, as inferred from the theory and laboratory experiments of a nonhomogeneous magnetoplasma. A drift wave excited at the plasmapause may propagate eastwards nearly perpendicular to the magnetic field, and tends to convert very soon to an ion sound wave with a much larger phase velocity parallel to the magnetic field. This may be a possible source mechanism for long-period geomagnetic micropulsations. The possibility of field-aligned plasma irregularities or ducts near the plasmapause may facilitate the mode coupling between ion sound, fast (or magnetosonic) and slow Alfvén waves when the parallel wavelength of these waves is comparable with the scale of irregularities. The magnetosonic waves partly transfer to the fast Alfvén wave and are partly Landau-damped while the slow Alfvén wave propagates along a field-aligned duct down to ionospheric heights, partly coupling to the fast Alfvén wave. This may be a possible excitation mechanism for short-period micropulsations (Pc-1,2) and indicates the role of the universal instability originated at the plasmapause in these geomagnetic micropulsations. These arguments are made clear on the basis of a theory of the universal instability which takes into account the coupling of electrostatic ion waves to Alfvén waves, and are also examined, based upon satellite plasma and ground micropulsation data. (M.O.W.)

48776 DEFORMATION AND STRIATION OF BARIUM CLOUDS IN THE IONOSPHERE. Perkins, F. W.; Zabusky, N. J.; Doles, J. H. (Bell Telephone Labs., Whippany, N. J.). pp 55-60 of Cosmic Plasma Physics. /Schindler, Karl (ed.). New York, Plenum Publishing Corp. (1972).

From Conference on cosmic plasma physics; Frascati, Italy (20 Sep 1971). See CONF-710951.

The nonlinear dynamics of barium clouds in the ionosphere can be described by a pair of coupled nonlinear partial differential equations in the two dimensions transverse to the magnetic field when $\Omega_i/\nu_{in} \gg 1$. These equations describe: (1) the variation of height-integrated plasma density N(x,y) caused by $E \times B$ drifts; and (2) the potential problem resulting from the requirement that the divergence of the Pederson current vanish. Numerical integrations of these equations on various spatial mesh sizes show: a steep "backside" density gradient, anomalous cloud broadening, and striations—phenomena observed in ionospheric barium releases. Analytic investigations of the linear stability of barium cloud models (including variations along the magnetic field) show that parallel resistivity mainly determines the short-wavelength cutoff for striation formation. These results are compared to other theoretical descriptions of barium clouds and to the observations. (auth)

48777 DISTURBANCE OF THE IONOSPHERE BY RADIO WAVES. Gurevich, A. V. (Lebedev Inst. of Physics, Moscow). Geomagn. Aeron. (USSR) (Engl. Transl.); 11: No. 6, 803-9(1971).

Translated from Geomagn. Aeron.; 11: No. 6, 953-60(1971).

The disturbance of the ionospheric plasma in the field of strong radio waves is analyzed. It is demonstrated that the electron density N increases at heights $z \leq 200$ km under the effect of the wave field ($\Delta N > 0$). Electron density disturbances are insignificant in the range $200 \leq z \leq (250 \text{ to } 300)$ km. In the region of the F-layer maximum ($z \sim 300$ to 400 km) and above it the N disturbances increase again in magnitude ($\Delta N < 0$). (auth)

48778 ANOMALOUS INCREASE OF F-REGION IONIZATION IN THE EVENING. Mamrukov, A. P. (Inst. of Cosmophysical Investigations and Aeronomy, Yakutsk, USSR). Geomagn. Aeron. (USSR) (Engl. Transl.); 11: No. 6, 830-3(1971).

Translated from Geomagn. Aeron.; 11: No. 6, 984-8(1971).

The time and space variations of the evening anomaly in F-layer ionization are analyzed. It is demonstrated that this phenomenon varies regularly with the seasons, is maximal in the Northern Hemisphere during the summer solstice at the corrected geomagnetic latitude of $\Phi' \approx 55°$N near the 180th geomagnetic meridian (Yakutsk), and is directly associated with the solar-activity level. A similar effect is observed in the Southern Hemisphere in a region (Port Lockroy) diametrically opposite that of Yakutsk. (auth)

48779 FORECASTING THE CHARACTERISTICS OF THE NORMAL IONOSPHERIC E LAYER. Ivanov, V. V.; Stepanov, B. M.; Fil'chenkov, M. L. Geomagn. Aeron. (USSR) (Engl. Transl.); 11: No. 6, 834-6(1971).

Translated from Geomagn. Aeron.; 11: No. 6, 989-92(1971).

The possibility of reconstructing the height-frequency characteristic to within 2 km from h′E and f_{min} measurements is examined. It is demonstrated that the dependence of this characteristic on the time of day, season, and geographic coordinates is determined by the solar zenith angle. This makes it possible to forecast the height-frequency characteristic of the E layer for any point on Earth at a given instant of time to within 2 km. (auth)

48780 WAVE-LIKE IONOSPHERIC DISTURBANCES AND SIGNAL PHASE CHARACTERISTICS. Afraimovich, E. L. (Ionospheric Sector, Alma-Ata, USSR). Geomagn. Aeron. (USSR) (Engl. Transl.); 11: No. 6, 837-40(1971).

Translated from Geomagn. Aeron.; 11: No. 6, 993-6(1971).

The effect of wave-like ionospheric disturbances (WID) on signal phase characteristics during vertical ionospheric soundings is analyzed. These parameters are sensitive enough to WID. The results of measurements illustrating the theoretically predicted modulation by the disturbing wave of the polarization period of envelope fadings are presented. (auth)

48781 SLIDING EFFECT AND OTHER ANOMALIES OF THE DIURNAL CYCLE OF THE VLF PHASE. Krasnushkin, P. E.; Sopel'nikov, M. D.; Fedorov, E. N. (Inst. of Mathematics, Moscow. Kharkov State Inst. of Meteorology). Geomagn. Aeron. (USSR) (Engl. Transl.); 11: No. 6, 841-4(1971).

Translated from Geomagn. Aeron.; 11: No. 6, 997-1002(1971).

The diurnal phases and amplitudes of cycles are computed for various changes of the parameters of the lower ionosphere. It is shown that three types of diurnal phase cycles are possible at a certain distance from the emitter because of the interference of two types of waves arising at the transmission point, namely: a trapezoidal cycle; a cycle with two maxima; and a cycle with the phase sliding by 360°. All three cycles were found experimentally during measurement of the phase of GBR radio station (16 kHz) at distances of 2200 to 2600 km. (auth)

48782 CHARACTERISTIC RADIO NOISE OF THE AURORAL IONOSPHERE. Bozhkov, A. I.; Osipov, N. K. (Radio Engineering Inst., Moscow). Geomagn. Aeron. (USSR) (Engl. Transl.); 11: No. 6, 859-62(1971).

Translated from Geomagn. Aeron.; 11: No. 6, 1021-5(1971).

Attention is drawn to the existence of three types of characteristic radio noise of the auroral ionosphere: noise of the burst type, noise with a slowly-varying component, and a radio storm. The given energy estimates indicate that the main mechanisms of generation of these types of noise are the effects of the interaction of charged particles with the atmosphere and, specifically, the effects of charge exchange of accelerated protons. (auth)

48783 EFFECT OF THE RING CURRENT ON IONOSPHERIC F-REGION DISTURBANCE. Zevakina, R. A.; Goncharova, E. E.; Pushkova, G. N.; Yudovich, L. A. (Inst. of Terrestrial Magnetism, Ionosphere, and Radio Wave Propagation, Moscow). Geomagn. Aeron. (USSR) (Engl. Transl.); 11: No. 6, 825-9(1971).

Translated from Geomagn. Aeron.; 11: No. 6, 977-83(1971).

It is demonstrated that at middle latitudes $D_{st}(\Delta f_0 F_2)$ varies synchronously with $D_{st}(H)$ and is maximal on magnetic shells where the ring current intensifies. This argument speaks in favor of a relationship between $D_{st}(\Delta f_0F_2)$ and the ring current. The role played by the ring current in ionospheric disturbance is discussed. (auth)

48784 EFFECT OF VERTICAL MOTIONS ON THE DISTRIBUTION OF O^+ IONS IN THE LOWER PART OF THE F REGION. Fatkullin, M. N.; Deminov, M. G. (Inst. of Terrestrial Magnetism, Ionosphere, and Radio Wave Propagation, Moscow). Geomagn. Aeron. (USSR) (Engl. Transl.); 11: No. 6, 818-24(1971).

Translated from Geomagn. Aeron.; 11: No. 6, 970-6(1971).

The steady-state continuity equation for O^+ ions is solved with allowance for the processes of production, recombination, and vertical motion. In the general case the solution is obtained in the form of an infinite series. But the series converges rapidly for the existing models of the upper atmosphere and velocities of motion. Two types of height dependence of motion are analyzed: homogeneous and exponential. It is demonstrated that the downward motion of O^+ ions can produce an additional peak at heights $h \leq h_mF_2$. (auth)

48785 STABILITY OF THE DYNAMIC MODEL OF THE IONOSPHERIC F REGION. Sidorov, N. A. (Irkutsk State Univ., USSR). Geomagn. Aeron. (USSR) (Engl. Transl.); 11: No. 6, 910-11(1971).

Translated from Geomagn. Aeron.; 11: No. 6, 1084-5(1971).

The problem of the stability of solutions of continuity equations for an ion—electron gas, presented in 1969 by Polyakov et al. is discussed. The system of equations considered are: $(\partial N/\partial t) = q - \alpha NM^+ + (\partial/\partial z)\ \{D[(\partial N/\partial z) + (N/H_i)]\}$; $(\partial M^+/\partial t) = \gamma\mu\ (N - M^+) - \alpha NM^+$, where N is electron density; q is the electron production rate; α is the weighted average dissociative recombination coefficient; M^+ is the concentration of molecular ions; D is the diffusion coefficient; H_i is the scale height of the electron—ion gas; γ is the weighted average ion—molecule reaction coefficient; and μ is the concentration of molecules. Conditions are established whereby the dynamic model (equations above) is stable, and solution of some problems of ionospheric dynamics is justified. (J.C.W.)

48786 UNIFIED COORDINATE SYSTEM FOR DESCRIBING THE GLOBAL DISTRIBUTION OF IONOSPHERIC PARAMETERS. Chernyshev, O. V. (Moscow Electrical Engineering Inst. of Communications). Geomagn. Aeron. (USSR) (Engl. Transl.); 11: No. 6, 912-13(1971).

Translated from Geomagn. Aeron.; 11: No. 6, 1086-7(1971).

The difficulty involved in the analytical description of the global distribution of ionospheric parameters lies largely in the complexity of the patterns of variation of a specific parameter in some coordinate system. Selection of an appropriate coordinate system depends on the distribution characteristics of the given parameter and the coordinate systems selected for each parameter are discussed. The possibility of using a unified coordinate system was investigated by analyzing the f_0F2 parameters and the transmission coefficient F2-M-3000. The investigation covers the monthly median f_0F2 and F2-M-3000 values of the global network of ionospheric stations for April 1958 and 1964. (J.C.W.)

48787 DISTRIBUTION OF THE FREQUENCY OF APPEARANCE OF THE E_s LAYER AT POLAR LATITUDES AS A FUNCTION OF LIMITING FREQUENCY. Artem'eva, G. M.; Pisareva, V. V. (Gorky State Univ., USSR). Geomagn. Aeron. (USSR) (Engl. Transl.); 11: No. 6, 914-15(1971).

Translated from Geomagn. Aeron.; 11: No. 6, 1087-8(1971).

The space—time distribution of the frequency of appearance of sporadic layers, pE_s, with $f_0E_s > 3$ and >5 MHz was obtained from an analysis of ionospheric data for 1960 at high-latitude stations. That of pE_s with $f_0E_s > 3$ MHz coincided with the distribution obtained earlier for the IGY period, i.e., it was characterized by a maximum value in the auroral zone and two maxima, in the morning and evening, in its diurnal pattern that merged into a single midnight maximum at the southern boundary of the zone. But the distribution of pE_s with $f_0E_s > 5$ MHz for zonal stations has a maximum in the evening and almost no morning maximum. This marked change in the shape of the diurnal pE_s pattern as a function of f_0E_s is observed frequently at auroral stations and is rare at polar stations. To determine the reasons for this difference, diurnal patterns of pE_s with $f_0E_s > 3$ and >5 MHz for sporadic layers of different types were constructed, and the contribution of each to the total value of pE_s was estimated. (J.C.W.)

48788 ROLE OF METEORS IN E_s FORMATION. Donii, V. N. (Kiev State Univ.). Geomagn. Aeron. (USSR) (Engl. Transl.); 11: No. 6, 915-16(1971).

Translated from Geomagn. Aeron.; 11: No. 6, 1089(1971).

A mechanism of E_s cloud formation from meteoric atoms and ions produced from the ablation of meteoroids has been proposed and the combination of parameters most completely describing the relationship between the activity of sporadic meteors and E_s-layer formation has been established and confirmed by rocket measurements. The relation $\overline{PE}_s = f(N_{max})$ has been proposed to describe the relationship between meteor activity and E_s-layer formation, where $\overline{PE}_s$ is the average probability of E_s during daylight and N_{max} is the maximum hourly number of recorded meteors. But this relationship has been verified experimentally only for a short time interval, for 7 months in 1965. Furthermore, the dependence of $\overline{PE}_s$ on the average diurnal hourly number of recorded meteors, N_{av}, is more justified from the viewpoint of the meteor hypothesis of E_s formation because the higher level of accretion can be correlated with a higher E_s probability. Therefore it is interesting to verify the validity of $PE_s = f(N_{max})$ over another, longer period of time and to clarify the existence and nature of the relationship between $\overline{PE}_s$ and N_{av}. For this purpose, meteor observations ($\lambda = 8.7$ m) were performed in 1968—1969, the results of which were compared with data of a standard ionospheric station located 100 km to the north of the meteor station. The results of observations during 10 months in 1968—1969 were used to construct a curve of the average probability of E_s, $\overline{PE}_s$, during daylight as a function of the maximum hourly number of meteors N_{max} and support the results of observations in 1965. (J.C.W.)

48789 N(h) PROFILES IN THE IONOSPHERIC D REGION DURING A SUDDEN IONOSPHERIC DISTURBANCE. Belikovich, V. V.; Benediktov, E. A.; Grishkevich, L. V.; (and others) (Gorky State Univ., USSR). Geomagn. Aeron. (USSR) (Engl. Transl.); 11: No. 6, 916-18(1971).

Translated from Geomagn. Aeron.; 11: No. 6, 1090-1(1971).

The penetration of a chromospheric-flare-associated x-ray burst into the Earth's atmosphere produces an anomalous increase in electron density N in the ionospheric D region. Specific measurements of N(h) profiles in the D region during a weak SID are analyzed from the riometer records for f = MHz at approximately 10h 30m on Oct. 24, 1969 that lasted until 11h 40m. Solar radio-noise bursts were recorded simultaneously in the cm-wave range. It is stated that a comparison of the nature of variation of N(h) profiles in the D region during SID with the spectral parameters of solar x rays can be used to estimate the height dependence of the effective recombination coefficient in the lower ionosphere. (J.C.W.)

48790 DETERMINATION OF THE ELECTRON DENSITY PROFILE IN THE LOWER IONOSPHERE AT HIGH LATITUDES FROM RIOMETER OBSERVATIONS. Novikov, Yu. P. (Polar Geophysical Inst., Kola, USSR). Geomagn. Aeron. (USSR) (Engl. Transl.); 11: No. 6, 918-21(1971).

Translated from Geomagn. Aeron.; 11: No. 6, 1092-4(1971).

The electron density and the effective collision frequency profiles obtained by the Ferdinand-1 rocket during a strong polar absorption event were used to study a method for the determination of the electron profile in the lower ionosphere at high latitudes. The values of integral cosmic radio noise absorption at frequencies f = 10, 15, 20, and 25 MHz were obtained by numerical integration in the height interval $50 \leq z \leq 80$ km for measured values of N(z) and $\nu(z)$; N(z) is the electron density at z height and $\nu(z)$ is the effective collision frequency at z height. (J.C.W.)

48791 METHOD OF MEASURING IONOSPHERIC DRIFTS. Zakharov, V. N. (Inst. of Terrestrial Magnetism, Ionosphere, and Radio Wave Propagation, Novosibirsk, USSR). Geomagn. Aeron. (USSR) (Engl. Transl.); 11: No. 6, 925-7(1971).

Translated from Geomagn. Aeron.; 11: No. 6, 1098-9(1971).

Previous observations of ionospheric drifts at Halley Bay Station (Antarctica) by the method of spaced reception showed the drift parameters to depend strongly on the orientation of the receiving antennas. Results of 550 measurements at middle latitudes were analyzed for June 1968 to April 1969 at a frequency of 2.2 MHz in one month of every season on a 24-hour schedule with two 5-min recording sessions per hour. The arrangement of the 3 antennas is described. The speed and direction of drift were determined by the method of similar fadings for each of the triangular antenna spacings. Results of the drift measurements by the similar fadings method apparently depend little on the orientation of the receiving antennas. The variance may be attributable to the difference in observation conditions; data given refer to high latitudes and, owing to the small separation of the antennas, a finer structure was probably measured in the previous observations. (J.C.W.)

48792 DETERMINATION OF THE CRITICAL FREQUENCIES AND GEOMETRIC PARAMETERS OF A PARABOLIC MODEL OF AN IONOSPHERIC LAYER DURING OBLIQUE SOUNDINGS. Kuz'min, E. L.; Kol'tsov, V. V. (Leningrad Electrical Engineering Inst. of Communications). Geomagn. Aeron. (USSR) (Engl. Transl.); 11: No. 6, 927-9(1971).

Translated from Geomagn. Aeron.; 11: No. 6, 1100-1(1971).

Two different distance-frequency characteristics DFC-1, corresponding to the minimum group path p_{min}, and DFC-2, corresponding to the minimum distance along the Earth D_{min} (distance to the landing edge of the illuminated wave), can be obtained during oblique soundings of the ionosphere at a variable frequency. The DFC-1 used is usually constructed from the frequency dependence of the time of arrival of the leading edge of a scattered signal. In this case it is possible to determine from the form of the DFC-1 only one of the three parameters of the parabolic model of an ionospheric layer. It is demonstrated that all three parameters can be found by using DFC-2, which can be constructed from the frequency dependence of the time of arrival of the first maximum of the scattered signal. (J.C.W.)

48793 PROBE MEASUREMENTS OF ELECTRON DENSITY AND TEMPERATURE IN THE IONOSPHERE. Burakov, Yu. B.; Komrakov, G. P.; Popkov, I. V.; Khryukin, V. G.; Chasovitin, Yu. K. (Gorky State Univ., USSR). Geomagn. Aeron. (USSR) (Engl. Transl.): 11: No. 6, 932-5(1971).

Translated from Geomagn. Aeron.; 11: No. 6, 1105-7(1971).

Two rocket experiments for measuring electron density N_e and temperature T_e in the ionosphere were performed in Jan. 1969 and the rockets reached heights of 170 to 174 km. Electron-density profiles were obtained in the height interval 77 to 170 km. The relationship of maximum and minimum temperature profiles to electron densities is discussed. The relationship of the distribution of dust particles to electron densities is presented. The electron temperature profiles in the height interval 85 to 174 km are given and the first experiment shows an increase fairly monotonically from 400 to 500°K at 90 km to 110 to 1200°K at 170 km, and in the second experiment the temperature increases more or less monotonically from approximately 500°K at 90 km to 1500°K at 168 km and then T_e grows rapidly to 2000°K. Computations show that the ion production rate usually varies with the solar zenith angle more rapidly than the heat flux. The result is that as the solar zenith angle increases, electron density decreases while electron temperature increases because of a decrease in the rate of loss of energy by the electron gas, as is also shown experimentally. (J.C.W.)

48794 EFFECT OF INTERNAL ATMOSPHERIC GRAVITY WAVES ON SOME OF THE IONOSPHERIC PARAMETERS DETERMINED IN VERTICAL SOUNDING. Afraimovich, E. L.; Rybin, V. A.; Troitskii, B. V. (Ionospheric Sector, Alma-Ata, USSR). Geomagn. Aeron. (USSR) (Engl. Transl.)· 11: No. 6, 935-8(1971).

Translated from Geomagn. Aeron.; 11: No. 6, 1108-10(1971).

Parameters from vertical soundings of the E and F regions were used to deduce the effect of internal atmospheric gravity waves on ionospheric parameters. Spatial electron-density computations were presented with and without the effect of the disturbance for daytime and nighttime. The critical frequency and the height of the ionization maximum, associated with the passage of a gravity wave, were assumed to vary periodically and results were given considering the varying intensities and frequencies of the disturbances. The computations were performed on a BESM-3M computer. (J.C.W.)

48795 UNUSUAL IONOSPHERIC DISTURBANCE. Belikovich, V. V.; Benediktov, E. A.; Vasin, V. A.; Grishkevich, L. V. (Gorky State Univ., USSR). Geomagn. Aeron. (USSR) (Engl. Transl.); 11: No. 6, 944-5(1971).

Translated from Geomagn. Aeron.; 11: No. 6, 1117(1971).

Strong spread reflections from the F2 layer and a considerable increase in critical frequencies were recorded on ionograms at middle latitudes on the nightside of the Northern Hemisphere during the magnetic storm of Dec. 2, 1967. Ionospheric sounder data in Gorkii indicated the critical frequency increased from 2 to 4.25 MHz during the period. At the same time, the Gorkii station observed a decrease in cosmic radio-noise intensity at frequencies of 9, 13, and 25 MHz. The cosmic radio-noise level weakened by as much as 1.2, 0.4, and 0.1 dB at these frequencies respectively. Since the f_{min} values did not change on the ionograms during this period, this decrease in signal levels on the riometer records was produced by processes in the F region. The decrease in cosmic radio-noise intensity at f = 9 MHz at night is an unusual event. The explanation for this phenomenon is discussed and it is assumed that a marked and predominant part of the decrease in cosmic radio-noise intensity was associated with the backscattering of radio waves by small-scale ionization inhomogeneities in the F region. It is noted that during the maximum phase of the disturbance the general decrease in cosmic radio-noise level did not exceed 0.1 dB at f = 25 MHz indicating that the effect of scattering of radio waves at f ≥ 25 MHz is insignificant in the midlatitude ionosphere and serves as an additional consideration against the existence of an extra component of cosmic radio-noise absorption. (J.C.W.)

48796 PHYSICS OF THE UPPER ATMOSPHERE. International School of Atmospheric Physics. Proceedings of the 1st Course, Erice, Italy, June 15–29, 1970. Verniani, Franco (ed.). Bologna; Editrice Compositori (1971). 480p. (CONF-700669).

The papers included in the book are: Some Aspects of Ionospheric Physics Today; Composition Studies of the Lower Ionosphere; Thermodynamics of the Ionosphere; Thomson Scatter Studies of Electron and Ion Temperature in the Ionosphere; Dynamics of the Upper Ionosphere; Measurements of Total Electron Content by Means of Satellite Radio Emissions; Geomagnetic Field and Magnetosphere; The Upper Atmosphere: Introductory Remarks; Structure of the Thermosphere and its Variations, Deduced from Satellite Decay; A Simplified Theory of the Temperature and Density Variations of the Upper Atmosphere; Helium and Hydrogen Distributions in the Upper Atmosphere; Physics of Neutral Constituents in Planetary Exospheres; Mass Spectrometric Studies of the Lower Thermosphere; Infrared Cooling by Atomic Oxygen in the Thermosphere; and Use of Optical Radars for Atmospheric Studies. (J.C.W.)

48797 FORMATION OF AURORAL PATCHES IN THE MIDDAY SECTOR DURING A SUBSTORM. Snyder, A. L. (Univ. of Alaska, College); Buchau, J.; Akasofu, S.-I. Planet. Space Sci.; 20: No. 7, 1116-19(Jul 1972).

The formation of auroral patches well equatorward of the oval in the midday sector was confirmed by an aircraft observation on Dec. 9, 1969. An airborne ionospheric sounder indicated the simultaneous absorption event, substantiating the precipitation and the associated ionization in the lower ionosphere. Observations made by all-sky camera, ionosonde, and photometers are given. It is suggested that the formation of patchy auroras in the midday sector is associated with the drift motion of energetic electrons and their subsequent precipitation. (UK)

Effects of Nuclear Detonations

48798 (SC-RR-720400) IONOSPHERIC MODIFICATION OF THE ELECTROMAGNETIC PULSE FROM NUCLEAR EXPLOSIONS. Jones, R. D.; Ring, D. Z. (Sandia Labs., Albuquerque, N. Mex.). Jul 1972. 30p. Dep. NTIS.

Dispersive effects of the ionosphere impose constraints on satellite electromagnetic pulse (EMP) sensors for nuclear-explosion detection. Dispersion is more effective than absorption in reducing the EMP hazard to soft low-altitude satellites. An estimate of the EMP in the time domain is obtained by convolving a truncated Fourier series approximation of the source signal with the impulse response function of the ionosphere. (auth)

Particle Kinetics and Trapping

Refer also to abstract 48693.

48799 PROPERTIES OF MAGNETIC NEUTRAL-SHEET SYSTEMS. Cowley, S. W. H. (Imperial Coll. of Science and Tech., London). pp 273-81 of Cosmic Plasma Physics. /Schindler, Karl (ed.). New York, Plenum Publishing Corp. (1972).

From Conference on cosmic plasma physics; Frascati, Italy (20 Sep 1971). See CONF-710951.

Work in the past two decades devoted to the investigation of the properties of the flow of a highly conducting fluid near x-type neutral lines in the magnetic field is briefly reviewed. A theory for the formation of the geomagnetotail is presented. (W.D.M.)

48800 FIELD-LINE MOTION IN THE PRESENCE OF FINITE CONDUCTIVITY. Birmingham, Thomas J. (Goddard Space Flight Center, Greenbelt, Md.). pp 283-91 of Cosmic Plasma Physics. /Schindler, Karl (ed.). New York, Plenum Publishing Corp. (1972).

From Conference on cosmic plasma physics; Frascati, Italy (20 Sep 1971). See CONF-710951.

Plasma motion is related to field line motion when the conducting is imperfect. It is assumed that the magnetic field is a given, known function of space and time. It is further assumed that all field lines intersect an ideally conducting surface and are identified by their points of intersections. (W.D.M.)

48801 STRUCTURE OF THE EARTH'S BOW SHOCK. Bertotti, B. (European Space Research Inst., Frascati, Italy); Parkinson, D.; Schindler, K.; Goldberg, P. pp 319-25 of Cosmic Plasma Physics. /Schindler, Karl (ed.). New York, Plenum Publishing Corp. (1972).

From Conference on cosmic plasma physics; Frascati, Italy (20 Sep 1971). See CONF-710951.

The investigation described is an attempt to shed light on the structure of the Earth's bow shock wave. Unlike gas dynamic shocks collisionless plasma shocks can dissipate directed flow energy in a number of different ways. In some of the models the shock structure is governed by plasma–magnetic field interaction; in other cases the interaction is assumed to be predominantly electrostatic. In the bow shock the experimental evidence points to the presence of both magnetic and electrostatic fluctuations and no unambiguous picture exists, even on a qualitative basis, for the dissipation processes. No a-priori assumption is made about the nature of the interaction; this attitude arose after the failure of extensive attempts to construct predominantly magnetic models for strong shocks. A first indication was given earlier (Bertotti et al., 1970; Bertotti and Schindler, 1971) when it was suggested that, in the fluid picture, a viscous effect is probably dominant. This phenomenon is interpreted in terms of electrostatic subshocks. (auth)

48802 NONLINEAR THEORY OF CROSS-FIELD AND TWO-STREAM INSTABILITIES IN THE EQUATORIAL ELECTROJET. Rogister, Andre (European Space Research Inst., Frascati, Italy). pp 335-7 of Cosmic Plasma Physics. /Schindler, Karl (ed.). New York, Plenum Publishing Corp. (1972).

From Conference on cosmic plasma physics; Frascati, Italy (20 Sep 1971). See CONF-710951.

In the presence of crossed-field or resistive two-stream turbulence, a vertical electron flux develops in the equatorial electrojet. In order to preserve charge neutrality the vertical ion flux decreases accordingly. Hence, the secondary electric field and the east–west electrojet current also decrease. The two-stream instability will be quenched in that way when $\bar{v}_{ey}$ is of the order of c_s, the sound speed in the plasma. A nonlinear theory of the cross-field instability has also been developed in which the energy is transferred by mode coupling from large (linearly unstable) to small (linearly stable) wavelengths, where it is damped by classical diffusion. These combined mechanisms lead to the formation of an overall marginally stable electrojet plasma. (auth)

48803 INTENSITY VARIATIONS OF THE EASTERLY AND WESTERLY POLAR ELECTROJETS IN UNIVERSAL TIME. Afonina, R. G.; Fel'dshtein, Ya. I. (Inst. of Terrestrial Magnetism, Ionosphere, and Radio Wave Propagation, Moscow). Geomagn. Aeron. (USSR) (Engl. Transl.); 11: No. 6, 947-50(1971).

Translated from Geomagn. Aeron.; 11: No. 6, 1120-2(1971).

Data were given from experiments and computations for the determination of the AU and AL indices that describe the intensity of the easterly and westerly polar electrojets during definite intervals of UT. The investigations of the AU and AL variations are performed in relation to other geo- and heliophysical phenomena. The diurnal variation of AU and AL in UT is shown of their ratio on five international disturbed days in winter, the equinoxes, and summer for 1957–1964. The different diurnal intensity modulation of AU and AL in UT and also the different variation of this modulation with the seasons suggest that AU and AL are produced by essentially different physical causes. It is concluded that the winter solstice is most favorable to the generation of the westerly electrojet and the summer solstice to that of the easterly electrojet. (J.C.W.)

48804 SPACE–TIME CORRELATIONS DURING ADVANCE OF DISCONTINUITIES ON THE MAGNETOSPHERE. Ivanov, K. G. (Inst. of Terrestrial Magnetism, Ionosphere, and Radio Wave Propagation, Moscow). Geomagn. Aeron. (USSR) (Engl. Transl.); 11: No. 6, 863-7(1971).

Translated from Geomagn. Aeron.; 11: No. 6, 1026-31(1971).

Correlations are obtained for estimating the travel time of different types of discontinuities in an undisturbed solar wind and the time of commencement of corresponding geomagnetic effects on Earth. It is demonstrated that these correlations can be used to determine the types of discontinuities and, specifically, to distinguish tangential discontinuities from fast shock waves in the absence of information on the behavior of electron temperature. (auth)

48805 PATTERNS OF DISTRIBUTION OF AMPLITUDES OF GEOMAGNETIC PULSATIONS ALONG A MERIDIONAL PROFILE. Gudkova, V. A.; Raspopov, O. M.; Van'yan, L. L.; (and others) (Leningrad State Univ.). Geomagn. Aeron. (USSR) (Engl. Transl.); 11: No. 6, 950-2(1971).

Translated from Geomagn. Aeron.; 11: No. 6, 1123-5(1971).

An analysis of the spatial characteristics of geomagnetic pulsations recorded synchronously at Belgorod, Borok, Sogra, Lovozero, and Heiss in March–April 1968 was made. The stations are located within a relatively narrow interval of longitudes, making it possible to trace the behavior of the pulsations along a meridional profile. The behavior of Pc3 amplitudes along the meridional profile was analyzed. Curves were constructed of the amplitude of the horizontal component of the pulsations and of its individual components as a function of station latitude. The same pattern was shown. An analysis of Pc3 pulsations with a practically constant period of 18 to 45 sec recorded in Mar.–April 1968 along a meridional profile showed that their amplitude maximum and their source were located at $\phi = 60°$. It is noted that the amplitudes of two Pc4, recorded during the same period, increased with latitude. It was concluded that amplitudes of pulsations along a meridional profile were observed to decrease from north to south. (J.C.W.)

48806 SHOCK WAVE IN THE TAIL OF THE MAGNETOSPHERE AS THE REASON FOR THE ACTIVE PHASE OF A MAGNETOSPHERIC SUBSTORM. Lyatskii, V. B.; Mal'tsev, Yu. P. (Polar Geophysical Inst., Kola, USSR). Geomagn. Aeron. (USSR) (Engl. Transl.); 11: No. 6, 872-6(1971).

Translated from Geomagn. Aeron.; 11: No. 6, 1038-43(1971).

A mechanism is proposed for the impulsive collapse of magnetic lines of force drawn out from the Earth, which propagates into the tail of the magnetosphere and causes a magnetospheric substorm. The mechanism is based on the excitation of a shock wave in the neutral sheet of the tail of the magnetosphere that moves fairly rapidly and is magnetized in a particular manner by the solar-wind inhomogeneity. (auth)

48807 MAGNETOHYDRODYNAMIC WAVES AND MAGNETIC VARIATIONS. INVESTIGATION OF FLUCTUATIONS DURING GEOMAGNETIC STORMS. Best, A.; Lehmann, H.-R. (Central Heinrich Hertz Inst. of Solar Terrestrial Physics, Berlin). Geomagn. Aeron. (USSR) (Engl. Transl.); 11: No. 6, 877-83(1971).

Translated from Geomagn. Aeron.; 11: No. 6, 1044-52(1971).

An attempt is made to explain geomagnetic-field fluctuations by wave propagation on the basis of a statistical frequency analysis of fluctuations arising during geomagnetic storms and covering an average interval of periods from 20 to 120 min. Alfvén waves are used as the simplest hypothesis and their appearance and propagation in the solar wind and the magnetosphere are examined. (auth)

Solar Wind and Cosmic Ray Interactions

Refer also to abstract 49104.

48808 (N–71–38547) TWO-FLUID SOLAR WIND MODEL WITH ANISOTROPIC PROTON TEMPERATURE. Leer, E.; Axford, W. I. (California Univ., San Diego. Dept. of Applied Physics and Information Science). Sep 1971. 30p. (NASA-CR–123113). NTIS.

A two-fluid model of the solar wind with anisotropic proton temperature and allowing for extended coronal proton-heating is considered for the case of a purely radial and of a spiral magnetic field. Proton–proton Coulomb collisions, together with a spiral interplanetary magnetic field, are found to be sufficient to reduce the thermal anisotropy in the proton gas to a value in agreement with observations. Reasonable values are obtained for the flow velocity, number density, and the proton-temperature near the orbit of the Earth. (STAR)

48809 (N–72–18795) ANALYSIS OF SOLAR X-RAY DATA. Final Report. Teske, Richard G. (Michigan Univ., Ann Arbor. Dept. of Astronomy). Jan 1972. 68p. (NASA-CR–125600). NTIS.

Type-III solar bursts occurring in the absence of solar flares were observed to be accompanied by weak x radiation. The energy scale of an OSO-3 soft x-ray ion chamber was assessed using realistic theoretical x-ray spectra. Relationships between soft solar x rays and solar activity were investigated. These included optical studies, the role of the Type-III acceleration mechanism in establishing the soft x-ray source volume, H alpha–flare intensity variations, and gross magnetic-field structure. (STAR)

48810 (N–72–21828) DIRECT OBSERVATIONS OF LOW-ENERGY SOLAR ELECTRONS ASSOCIATED WITH A TYPE-3 SOLAR RADIO BURST. Frank, L. A.; Gurnett, D. A. (Iowa Univ., Iowa City. Dept. of Physics and Astronomy). Feb 1972. Contract NAS5-11039. 54p. (NASA-CR–125932). NTIS.

On April 6, 1971, a solar x-ray flare and a Type-III solar radio-noise burst were observed with instrumentation on the eccentric-orbiting satellite IMP 6. The Type-III solar radio-noise burst was detected down to a frequency of 31 kHz. A highly anisotropic packet of low-energy solar electron intensities arrived at the satellite approximately 6000 seconds after the onset of the solar flare. This packet of solar electron intensities was observed for 4200 seconds. Maximum differential intensities of the solar electrons were in the energy range of one to several keV. The frequency drift rate of the Type-III radio noise at frequencies below 178 kHz also indicated an average particle speed corresponding to that of a 3-keV electron. The simultaneous observations of these solar electron intensities and of the Type-III solar radio burst are presented, and their interrelationships are explored. (STAR)

48811 PROPAGATION OF SOLAR PROTONS IN THE SURROUNDINGS WITH CONSTANT AND ALTERNATING TRANSPORT RANGE DURING INSTANTANEOUS INJECTION IN THE VICINITY OF THE SUN. **Vernov, S. N.; Gorchakov, E. V.; Timofeev, G. A.** Izv. Akad. Nauk SSSR, Ser. Fiz.; 35: No. 12, 2423-7(Dec 1971). (In Russian).

The propagation of protons with E ~ 1 MeV injected by an instantaneous source near the Sun is examined. It is assumed that the normal magnetic field of the Sun varies with distance as r^{-2}. The interaction of protons with inhomogeneities is described by the assignment of a mean free path length and of an average angle of dispersion by the inhomogeneity. (tr-auth)

48812 STUDY OF THE SOLAR WIND BY DATA OF THE 11-YEAR MODULATION COSMIC RAYS. **Charakhch'yan, A. N.; Charakhch'yan, T. N.** (Moscow State Univ.). Izv. Akad. Nauk SSSR, Ser. Fiz.; 35: No. 12, 2488-91(Dec 1971). (In Russian).

Problems relating to the spatial dependence of the magnetic field of the solar wind $\bar{H}$ and the boundary r_0 to which they are propagated in interplanetary space are discussed. A decrease in $\bar{H}$ with the distance to the Sun, D, conforms approximately to the relation $H \sim 1/D$. The volume of the magnetic fields of the solar wind V increases with distance according to the rule $V \sim D^2$. Damping of the magnetic fields in space occurs chiefly in the region $r_0 = 10$ to 20 AU. (tr-auth)

48813 INTEGRAL PRODUCTION MULTIPLICITIES FOR COMPUTING THE SOLAR COSMIC-RAY SPECTRUM. **Miroshnichenko, L. I.** (Inst. of Terrestrial Magnetism, Ionosphere, and Radio Wave Propagation, Moscow). Geomagn. Aeron. (USSR) (Engl. Transl.): 11: No. 6, 904-7(1971).

Translated from Geomagn. Aeron.; 11: No. 6, 1077-80(1971).

To compute the absolute solar cosmic-ray flux from the ground-based observations the integral production multiplicity $m^i(R,h)$, i.e., the number of secondary particles of kind i produced in the atmosphere by a single primary particle of rigidity R and recorded at the level with a pressure h, must be known. If the m^i values are known, the differential solar cosmic-ray spectrum $D^S_{0+}(R)$ at the boundary of the atmosphere is determined by the relationship previously given by Dorman and Miroshnichenko, 1966, namely: $D^S_{0+}(R) = -(\partial F^i_s/\partial R)(1/m^i)$, where $\partial F^i_S/\partial R$ describes the latitude effect of solar particles. It is shown that from the relationship given with an allowance from the estimates of the absolute neutron flux of $(10 \pm 0.7) \times 10^{-4}$ cm^{-2} sec^{-1}, the absolute spectrum of solar cosmic rays at the boundary of the Earth from the data of the network of ground-based neutron detector stations in the region of rigidities $R \geq 1$ GV can be determined. (J.C.W.)

48814 DISTURBANCES OF THE PLASMA PARAMETERS OF THE SOLAR WIND. **Smirnova, L. P.; Shabanskii, V. P.** (Moscow State Univ. Inst. of Nuclear Physics, Moscow). Geomagn. Aeron. (USSR) (Engl. Transl.); 11: No. 6, 900-2(1971).

Translated from Geomagn. Aeron.; 11: No. 6, 1073-4(1971).

The development in the interplanetary plasma of inhomogeneities associated with irregular plasma outflow from the surface of the Sun is discussed. Because of the rotation of the Sun, an azimuthal velocity component appears during the interaction of fluxes of different velocities, which is responsible for nonradial solar-wind flow. Solutions of the problem of the development in space of disturbances in directional velocity and density were obtained in the plane case by Siscoe and Carovilano, 1969, and later, with allowance for the velocity component in the polar direction, by Siscoe and Finley, 1970. It is assumed that the velocity component perpendicular to the plane of the ecliptic is zero and that the magnetic pressure is small compared with the gaskinetic pressure. The problem is solved in the hydrodynamic approximation, disregarding thermal conductivity and viscosity. Small plasma density and velocity disturbances are analyzed. (J.C.W.)

48815 CALIBRATION OF MUON TELESCOPES DURING INVESTIGATIONS OF COSMIC-RAY VARIATIONS. **Frantsuz, E. T.** (Inst. of Terrestrial Magnetism, Ionosphere, and Radio Wave Propagation, Moscow). Geomagn. Aeron. (USSR) (Engl. Transl.); 11: No. 6, 897-9(1971).

Translated from Geomagn. Aeron.; 11: No. 6, 1069-72(1971).

It is suggested that muon telescopes be calibrated by comparing their data with those of a "standard" telescope with a varying aperture, the geometric factor of which can be measured with the necessary accuracy. (auth)

48816 SPECTRAL CHARACTERISTICS OF THE TERRESTRIAL AND INTERPLANETARY MAGNETIC FIELDS IN THE FREQUENCY RANGE 1 TO 10^{-4} Hz. **Dubrovskii, V. G.; Kramarenko, S. A.** (Inst. of Terrestrial and Atmospheric Physics, Ashkhabad, USSR). Geomagn. Aeron. (USSR) (Engl. Transl.); 11: No. 6, 884-9(1971).

Translated from Geomagn. Aeron.; 11: No. 6, 1053-60(1971).

The results of earlier spectral investigations of the terrestrial and interplanetary magnetic fields are analyzed. It is found that the variations of the spectral power density of both fields are described by a power function. The slope of the spectral power density of the geomagnetic field changes in the frequency range of micropulsations. The results of spectral investigations are compared with the computed graphs of spectral power density. (auth)

48817 ROTATIONAL DISCONTINUITY IN THE SOLAR WIND AND MAGNETIC DISTURBANCE ON EARTH. **Ivanov, K. G.; Mikerina, N. V.** (Inst. of Terrestrial Magnetism, Ionosphere, and Radio Wave Propagation, Moscow). Geomagn. Aeron. (USSR) (Engl. Transl.); 11: No. 6, 868-71(1971).

Translated from Geomagn. Aeron.; 11: No. 6, 1032-7(1971).

The magnetic effect of the anisotropic rotational discontinuity of October 28, 1967, on Earth, i.e., the sudden commencement (SSC) and initial phase (IP) of the storm, is studied. It is demonstrated that the IP phase is observed after the front of the discontinuity crosses the frontal part of the magnetosphere and is nonstationary, i.e., the high-latitude ionospheric current attenuates with a characteristic time of ~30 to 40 min. A qualitative explanation is given of the main properties of the discontinuity effect. (auth)

48818 RELATIVE ROLE OF FACTORS THAT LIMIT THE SOLAR WIND. **Dorman, L. I.** (Inst. of Terrestrial Magnetism, Ionosphere, and Radio Wave Propagation, Moscow). Geomagn. Aeron. (USSR) (Engl. Transl.); 11: No. 6, 797-9(1971).

Translated from Geomagn. Aeron.; 11: No. 6, 945-8(1971).

The following factors that limit the solar wind are discussed and evaluated: 1) the magnetic field of the galactic spiral within which the solar system is located; 2) the static and dynamic pressures of the interplanetary medium; 3) the pressure of galactic cosmic rays; 4) charge exchange of solar-wind protons during collisions with the neutral hydrogen atoms of interplanetary space; and 5) energy losses of the solar wind through particle acceleration. (auth)

48819 REGRESSION ANALYSIS OF ATMOSPHERIC EFFECTS ON THE NEUTRON COMPONENT OF COSMIC RAYS. **Akhababyan, N.; Aleksandrov, L.** (Inst. of Physics, Sofia). Geomagn. Aeron. (USSR) (Engl. Transl.); 11: No. 6, 800-2(1971).

Translated from Geomagn. Aeron.; 11: No. 6, 949-52(1971).

The effect of various atmospheric factors on the intensity of the neutron component of cosmic rays is investigated by multi-factor regression analysis. Application of Fisher's criterion to the "sum of residual squares" makes it possible to estimate the significance of each of these factors. (auth)

PHYSICS (ATOMIC AND MOLECULAR)

Atomic, Electron, Ion, and Molecular Beams and Their Reactions

Refer also to abstracts 49533, 49759, and 49770.

48820 (IPPJ–115) STABILITY OF HIGH INTENSITY ELECTRON BEAM. Ikuta, Kazunari (Nagoya Univ. (Japan). Inst. of Plasma Physics). Nov 1971. 12p. NTIS (U. S. Sales Only).

A stability condition is obtained for a general configuration of a high-intensity neutralized electron beam and is applied to cylindrical beam systems. Neutralized cylindrical beam systems are stable if the total beam current sufficiently exceeds 10^4 A. (auth)

48821 (UCRL-Trans–1456) ON THE STATIONARY STATE OF A CHARGED SELF-FOCUSING BEAM OF HIGH CURRENT. Bonch-Osmolovskii, A. G.; Surovtsev, Yu. S. (Joint Inst. for Nuclear Research, Dubna (USSR)). Translated by G. Brodel (Univ. of California, Lawrence Berkeley Lab., Berkeley), from report JINR–P9-5857. 13p. Dep. NTIS.

The properties of relativistic self-focusing beams are considered in the self-consistent-field model. The possible existence of the charged state of such beams is shown, and the neutralization limits for the equilibrium conditions are established. (auth)

48822 DIRECT OBSERVATION OF Kα HYPERSATELLITES IN HEAVY-ION COLLISIONS. Richard, Patrick; Hodge, W.; Moore, C. Fred (Univ. of Texas, Austin). Phys. Rev. Lett.; 29: No. 7, 393-5(14 Aug 1972).

It is demonstrated that bombardment of Ca by 30-MeV oxygen ions produces a Kα spectrum consisting of hypersatellite lines. Kα hypersatellites are 1s → 2p transitions in an atom with two 1s electron vacancies in the initial state. (auth)

48823 PRODUCTION OF BEAMS OF EXCITED ENERGETIC NEUTRAL PARTICLES. Futch, Archer H. Jr.; McFarland, Robert H. (to United States Atomic Energy Commission). U. S. Patent 3,657,542. 18 Apr 1972. Filed 4 May 1970.

Excited energetic neutral particle beams are produced, in accordance with one method, by directing a low-energy ion beam through a gaseous medium under thick-target conditions. In accordance with a second method, the low-energy ions, i.e., below 10 keV, are directed through a first gaseous medium at which resonance or near resonance charge exchange neutralization occurs and the neutral particles are then passed through a second gaseous medium in which the particles are excited to high n-quantum levels. In either case the excited-state neutral particles can then be more easily ionized by the Lorentz force when they are introduced into a magnetic containment field to form a plasma. The second gaseous medium generally comprises a different gas from the first, and is specially selected to produce the maximum portion of excited states. (4 figures) (auth)

48824 METHOD FOR SURFACE ANALYSIS BY SPUTTERED NEUTRALS. Oechsner, H.; Gerhard, W. (Univ., Wuerzburg, Ger.). Phys. Lett.; 40A: No. 3, 211-12(17 Jul 1972).

An experimental arrangement for mass spectrometric analysis of sputtered neutrals using a low-pressure electrodeless hf discharge is described. Possible application for the analysis of a surface layer is demonstrated. (auth)

48825 FOCUSING IN SPUTTERING. Chadderton, L. T.; Johansen, A.; Sarholt-Kristensen, L.; (and others) (Oersted Inst., Copenhagen). Phys. Lett.; 40A: No. 3, 231-2(17 Jul 1972).

Results from bombardment of Au by Ar$^+$ at 30 to 85 keV are used to show how variations in spot structure on sputtered ejection patterns can arise from bulk correlated collision sequences in atomic cascades. (auth)

48826 MEASUREMENT OF UV RADIATION FROM BEAM-FOIL EXCITED Li IONS. Schuermann, D.; Haas, D.; Heckmann, P. H.; Buttlar, H. v. (Univ., Bochum, Ger.). Phys. Lett.; 40A: No. 4, 323-4(31 Jul 1972).

Beam–foil-excited spectra of ^{6}Li$^+$ and ^{6}Li^{2+} were observed in the wavelength range 400 to 1500 Å. Radiative mean lives of the hydrogen-like ^{6}Li^{2+} ion were measured for the transitions 2p–3s and 2p–4s. The results are in agreement with theory. (auth)

48827 RECORD OF THE 11th SYMPOSIUM ON ELECTRON, ION, AND LASER BEAM TECHNOLOGY. Conference Held at Boulder, Colorado, May 12–14, 1971. Thornley, R. F. M. (ed.). IEEE Catalog No. 71 C 23-ED. New York; Institute of Electrical and Electronics Engineers, Inc. (1971). 703p. (CONF-710542). San Francisco Press, Inc.

Separate abstracts were prepared for 32 of the included papers. (M.O.W.)

For abstracts of individual papers see: 47975, 47976, 48140, 48158, 48159, 48498–48501, 48507–48510, 48519, 48520, 48527–48533, 48828–48831, 49547, 49554, 49569, 49664, 49665, and 49699.

48828 CHARACTERISTICS OF COOL, HIGH ν/γ ELECTRON-BEAM PROPAGATION. Bradley, Laird P. (Sandia Labs., Albuquerque, N. Mex.); Martin, T. H.; Prestwich, K. R.; (and others). pp 553-60 of Record of the 11th Symposium on Electron Ion, and Laser Beam Technology. /Thornley, R. F. M. (ed.). New York; Inst. of Electrical and Electronics Engineers, Inc. (1971).

From eleventh symposium on electron, ion, and laser beam technology; Boulder, Colo. (12 May 1971).

Three beam-handling concepts are of primary concern: transport, compression, and combination. Data showing the necessity and effect of coolness on each of these areas are presented. The cool, neutral-gas propagation approach is contrasted with the hot beam and with the superimposed magnetic-field approach where applicable. Beam transport was obtained, using ν/γ of 1 to 3 beams, with an e-folding distance of 4 to 6 m, fluence gain of 10, and 100% superposition with excellent uniformity. (auth)

48829 LARGE-DIAMETER ION SOURCE WITH VARIABLE-BEAM CROSS-SECTION CONFIGURATIONS. Meckel, Ben B. (Physics Tech. Labs., Inc., La Mesa, Calif.). pp 585-90 of Record of the 11th Symposium on Electron, Ion, and Laser Beam Technology. /Thornley, R. F. M. (ed.). New York; Inst. of Electrical and Electronics Engineers, Inc. (1971).

From eleventh symposium on electron, ion, and laser beam technology; Boulder, Colo. (12 May 1971).

A large-cross-section ion beam source has been developed and employed in R & D and industrial applications. The beam characteristics include variously shaped beam cross sections between 1 and 15 cm. Argon-ion currents of 0.1 to 1.0 mA/cm^2 are obtained at energies of 250 to 5000 eV. The technique of attaining these values over large areas is by extracting ions from an rf-generated plasma through many apertures located in a contoured sheet electrode. Each extraction point acts as a single source or individual ion beam, and by expanding and shaping the sheet electrode surface, a wide spectrum of beam parameters and configurations can be obtained. For example, the extraction sheet can be designed to produce a focused beam or irregular cross-sectional shapes. The broad beam is space-charge neutralized by injecting thermal electrons, resulting in the reduction of Coulomb spreading and charge accumulation on surfaces being bombarded. The beam is being used at present for sputter deposition of the thin films, ion bombardment cleaning of metal and nonmetal surfaces, bias sputtering of films being deposited on dielectric substrates, sample thinning for electron microscopy, and surface preparation for topographical investigations. Other applications include molecular-beam studies, solar plasma wind simulation, and thermonuclear reactor ion sources. (auth)

48830 BEAM–PLASMA TYPE ION SOURCE. Takagi, T.; Yamada, I.; Ishikawa, J. (Kyoto Univ.). pp 597-604 of Record of the 11th Symposium on Electron, Ion, and Laser Beam Technology. /Thornley, R. F. M. (ed.). New York; Inst. of Electrical and Electronics Engineers, Inc. (1971).

From eleventh symposium on electron, ion, and laser beam technology; Boulder, Colo. (12 May 1971).

Recently ion implantation into semiconductors, together with other such uses of ions, has been the subject of special interest, and various kinds of ion-beam sources have been developed. The common objective is to have devices that work in a stable condition, yielding fine, intense, and well-concentrated ion beams. These ion beams should also be capable of ionizing various types of metals as well as gases. To reduce the ion-beam radius, it is desirable to bring the beam into a focusing system immediately after the departure from the plasma-generation chamber. Ion sources developed to date include the thermionic-emission type, surface-ionization type, high-frequency discharge type, electron-bombardment type, PIG type, low-voltage arc type, duoplasmatron type, and others. A "beam–plasma" type of ion source has been developed in which an electron beam is used for the dual purpose of generation and focusing of plasmas. An outline of this device is given. (auth)

48831 ELECTRON-BOMBARDMENT-TYPE SIMPLIFIED ION SOURCE. Takagi, T.; Yamada, I.; Ishikawa, J. (Kyoto Univ.). pp 623-30 of Record of the 11th Symposium on Electron, Ion, and Laser Beam Technology. /Thornley, R. F. M. (ed.). New York; Inst. of Electrical and Electronics Engineers, Inc. (1971).

From eleventh symposium on electron, ion, and laser beam technology; Boulder, Colo. (12 May 1971).

Some properties of an electron-bombardment-type ion source for ion implantation are studied. The magnetic field induced by the filament heating current of filament coil which emits electrons in the discharge chamber is utilized effectively. A new simplified ion source without external magnetic field is designed and operating characteristics are measured. It is shown that intense and fine ion beams can be obtained easily from various kinds of materials not only in gaseous states, but also in solid states at room temperatures, because this new ion source works stably even at high temperatures. (auth)

48832 IDEALIZED SPATIAL EMISSION DISTRIBUTION OF SECONDARY ELECTRONS. Everhart, T. E.; Chung, M. S. (Univ. of California, Berkeley). J. Appl. Phys.; 43: No. 9, 3707-11(Sep 1972).

The spatial distribution of secondary electrons generated by a primary electron beam incident at a point of the sample surface is calculated for samples of varying thicknesses. The current density generated under these conditions is also calculated for several different angles of incidence. According to the calculations, which are based on a commonly used idealized model, most secondary electrons leave the sample within a mean free path of their point of excitation, which is 10 to 20 Å for metals. Because thin metal coatings are used to prevent many insulating samples from charging, these results relate to the ultimate resolution that one can expect in secondary-emission scanning electron microscopy. (auth)

48833 PROPOSAL ON MULTIPLY CHARGED ION SOURCE. Tamagawa, Hajime; Okamoto, Yukio; Akutagawa, Chitaka (Nagoya Univ., Japan). Jap. J. Appl. Phys.; 11: No. 8, 1226-7 (Aug 1972).

An apparatus used to produce and analyze multiply charged argon ions is described. A plasma is produced by a microwave source coupled to a Lisitano coil. Multiply charged ions are extracted from the plasma by an ion extraction electrode slightly beyond the magnetic mirror that confines the electrons. Present results on argon plasma show that 80% of the ions are doubly charged when the electron temperature of the plasma is about 35 eV and the microwave power is 150 watts. It is anticipated that higher charge states can be obtained by using a more powerful microwave source. (A.G.W.)

48834 ENERGY SPECTRA OF W^+ AND Mo^+ IONS OBTAINED IN THE SPUTTERING OF TUNGSTEN–MOLYBDENUM ALLOYS. Adylov, A. A.; Veksler, V. I.; Reznik, A. M.; Furer, S. A. (Tashkent State Univ.). Sov. Phys.-Solid State(Eng. Transl.); 14: No. 2, 396-8(Aug 1972).

Translated from Fiz. Tverd. Tela- 14: No. 2, 477-80(Feb 1972).

An experimental investigation was made of the energy spectra of the secondary W^+ and Mo^+ ions emitted in the cathode sputtering of 50% W–50% Mo and 99.2% W–0.8% Mo (wt %) alloys. The influence of changes in the target temperature on the energy spectra was investigated and a correlation was found between the nature of changes in the spectra of both ions. (auth)

48835 LOW-ENERGY ION REFLECTION FROM METAL SINGLE CRYSTALS. Van Veen, A.; Haak, J. (Rijksuniversiteit, Utrecht). Phys. Lett.; 40A: No. 5, 378-80(14 Aug 1972).

Energy and angular distributions of ions (50 to 500 eV) reflected from metal single crystals were computed. The neutralization process is involved in the computing model. The result indicates a strong dependence on the surface trajectories of the reflected particles. (auth)

Atomic and Molecular Properties

Refer also to abstracts 48862, 48863, and 48866–48868.

48836 FREQUENCY-DEPENDENT PROPERTIES OF THE HYDROGEN ATOM. A GENERALIZED EIGENVALUE EQUATION APPROACH. Woodward, M. R.; Amos, A. T. (Univ. of Nottingham, Eng.). Mol. Phys.; 23: No. 6, 1199-1210(Jun 1972).

The time-independent first-order perturbation equations that arise on considering the response of a system to a harmonic time-dependent perturbation are solved by using an expansion in terms of a complete discrete set of solutions of a generalized eigenvalue equation. Explicit formulae are obtained for several frequency-dependent properties of the hydrogen atom. (auth)

48837 ELECTRON SPECTROSCOPY. Aksela, S. (Oulu Univ., Finland). Soumen Kem.; 45: No. 3, 44-54(1972).

The physical principles of photoelectron, Auger electron, and ionization spectroscopy are presented, and the basic instrumental arrangements used in these main branches of electron spectroscopy are described. The results of a variety of applications to chemical, physical, and technical research problems illustrate the information to be gained from electron spectra. (Finland)

48838 MEASUREMENT OF THE RATIO OF THE MAGNETIC MOMENTS OF THE 2^3S_1 LEVEL OF ^4He AND GROUND LEVEL OF ^3He. Leduc, M.; Laloe, F.; Brossel, J. (Ecole Normale Superieure, Paris). J. Phys. (Paris); 33: No. 1, 49-58(Jan 1972). (In French).

A weak sustained discharge was applied to a gaseous mixture of ^3He and ^4He, and an optical pumping experiment was performed. The 2^3S_1 metastable state of ^4He and the 1^1S_0 ground state of ^3He were simultaneously oriented and their resonance frequencies were measured in the same magnetic field. Systematic errors were eliminated and the frequency ratio was obtained with good accuracy ($864.02392 \pm 6 \times 10^{-5}$). This result was combined with previous measurements to obtain a new value of the ratio of the electron Lande g factors: $1 - (21.6 \pm 0.5) \times 10^{-6}$. The value obtained slightly disagrees with a direct (but less precise) measurement and also with a theoretical value previously derived by other authors. (France)

48839 BINDING ENERGY OF A HYDROGEN ATOM IN A MAGNETIC FIELD. Callaway, Joseph (Louisiana State Univ., Baton Rouge). Phys. Lett.; 40A: No. 4, 331-2(31 Jul 1972).

The binding energy and lowest excitation energy of a hydrogen atom are calculated by a variational method for magnetic fields in the range 10^8 to 10^{11} gauss. (auth)

48840 KLL-AUGER TRANSITION ABSOLUTE PROBABILITIES, $30 \leq Z \leq 94$. Babenkov, M. I.; Bobykin, B. V.; Petukhov, V. K. (Inst. of Nuclear Physics, Alma-Ata, USSR). Phys. Lett.; 40A: No. 4, 347-8(31 Jul 1972).

Absolute probabilities of KLL-Auger transitions are determined for the elements with $30 \leq Z \leq 94$ on the basis of experimental information published by the middle of 1971. The known theories are shown not to describe KLL transitions completely. (auth)

48841 OBSERVATIONS OF ZEEMAN EFFECT IN THE OPTICAL SPECTRA OF FAST ION BEAMS. Stoner, John O. Jr. (Univ. of Arizona, Tucson); Radziemski, Leon J. Jr. Appl. Phys. Lett.; 21: No. 4, 165-6(15 Aug 1972).

Splittings between the σ_+ and σ_- groups of components of optical lines emitted by fast beams of Ar^+ and O^+ [$v/c = (3.2-4.2) \times 10^{-3}$] were observed in a magnetic field of 13,800 G. In order to observe these separations, which were of the order of 0.2 to 0.3 Å, it was necessary to reduce the recorded widths of spectral lines by refocusing the spectrometer and by exciting the beam in a gas target. (auth)

Positronium, Muonium, and Mesic Atoms and Molecules

Refer also to abstracts 48890, 49013, and 49752.

Collision Phenomena

48842 BIBLIOGRAPHY ON ATOMIC ENERGY LEVELS AND SPECTRA: JULY 1968 THROUGH JUNE 1971. Hagan, Lucy; Martin, W. C. (National Bureau of Standards, Washington, D. C.). Nat. Bur. Stand. (U. S.), Spec. Publ.; No. 363, 1-103(Jun 1972).

The bibliography contains approximately 1100 references classified by subject for individual atoms and atomic ions. A number index identifies the references. An author index is included. References included contain data on energy levels, classified lines, wavelengths, Zeeman effect, Stark effect, hyperfine structure, isotope shift, ionization potentials, or theory that gives results for specific atoms or atomic ions. (auth)

48843 VACANCY CASCADE SPECTROSCOPY: A CONVENIENT WAY OF STUDYING SPECTRA AND LIFETIMES OF HIGHLY IONIZED ATOMS AND MOLECULES. Erman, P. (Forskningsinstitutet foer Atomfysik, Stockholm); Berry, G.; Lundin, L.; Sigfridsson, B. FOA (Forsvarets Forsk.) Rep.; 6: No. 3, 1-9(Feb 1972). (CONF-710728-1).

From second European conference on beam-foil spectroscopy and connected topics; Lyon, France (20 Jul 1971).

Atomic vacancy cascades were created in various gases such as He, N_2, O_2, CO_2, Cl_2, Ar, and Xe, using a monoenergetic electron beam (2 to 10 keV, 0 to 10 mA). The resulting atomic and molecular spectra were studied in the region 500 to 2500 Å, using a grating spectrometer; they proved to be very intense with a broad distribution of charge states. It is shown that this experimental arrangement can easily be used for the determination of atomic and molecular lifetimes if the electron beam is swept in front of the gas volume using a high-frequency oscillator. Other attractive features of this light source are also discussed. (auth) (Sweden)

48844 SEMICLASSICAL NATURE OF ATOMIC AND MOLECULAR COLLISIONS. Miller, William H. (Univ. of California, Berkeley). Accounts Chem. Res.; 4: No. 5, 161-7 (May 1971).

It is shown that essentially all quantum mechanical effects in atomic and molecular collisions can be adequately treated within the framework of classical mechanics provided classical mechanics is used to construct the classical limit of the quantum mechanical transition amplitude, or S-matrix element, for the process of interest, which is then manipulated quantum mechanically. The Feynman propagator, the classical S matrix, classically forbidden transitions, and resonances are discussed. Vibrational excitation in a linear atom–diatom collision is treated as an example. (A.G.W.)

48845 DIFFERENTIAL AND DIRECT DIFFERENTIAL ELASTIC SCATTERING CROSS SECTIONS FOR ELECTRONS AND POTASSIUM ATOMS. Hils, D.; McCusker, M. V.; Kleinpoppen, H.; Smith, S. J. (Univ. of Colorado, Boulder). Phys. Rev. Lett.; 29: No. 7, 398-401(14 Aug 1972).

In a modulated crossed-beam experiment unpolarized electrons of 3.3 eV energy were elastically scattered from spin-polarized K atoms. A measurement of the polarization of the scattered electron yields $|f(\theta)|^2/\sigma(\theta)$. The measured values of $|f|^2/\sigma(\theta)$ show a significant angular shift relative to the theoretical curve in forward-angle scattering ($\theta = 20°$ to 40°). This shift is not apparent in measurements of the differential scattering cross section $\sigma(\theta)$ over the same angular range, which, however, do show a significant angular shift in the range $\theta = 50°$ to 120°. (auth)

48846 EXCITATION OF MOLECULAR VIBRATION ON COLLISION. SIMULTANEOUS VIBRATIONAL AND ROTATIONAL TRANSITIONS IN HYDROGEN + ARGON AT HIGH COLLISION VELOCITIES. Shin, Hyung Kyu (Univ. of Nevada, Reno). J. Phys. Chem.; 76: No. 14, 2006-13(6 Jul 1972).

Simultaneous vibrational and rotational transitions in H_2 + Ar at high collision velocities were studied by use of the sudden approximation. The probabilities of $0 \rightarrow 1$, $0 \rightarrow 2$, and $1 \rightarrow 2$ vibrational transitions simultaneously occurring with the rotational change of jm = 00 to 00, 20, or 40 at zero impact parameter in the velocity range of 10^6 to 10^7 cm/s were calculated. The perturbation energy has been derived from high-velocity beam experiments. Each simultaneous transition probability takes a maximum value at the neighborhood of 10^6 cm/s and then always decreases with increasing velocity. For a given vibrational transition, the $00 \rightarrow 20$ rotational change produces the largest energy transfer above 10^6 cm/s. The only important rotational transitions are found to be $00 \rightarrow 20$ and $00 \rightarrow 40$. Calculation is extended to the collision taking place at velocities lower than 10^6 cm/s to find the undulatory variation of the simultaneous transition probabilities. The vibrational transition probabilities at collinear and perpendicular orientations are also calculated. In the limit of high collision velocities, the collinear transition probability is larger than the orientation-averaged probability by a factor of 5.6 for both $0 \rightarrow 1$ and $1 \rightarrow 2$, and by 10 for $0 \rightarrow 2$; at lower velocities the factors seriously deviate from these values and furthermore they depend strongly on the velocity indicating that the orientation dependence of the vibrational transition probability cannot be given by any simple steric factor. (auth)

48847 LINEAR MOMENTUM TRANSFER EFFECTS IN MOLECULAR DISSOCIATION PRODUCED BY ELECTRON IMPACT. Misakian, Martin; Pearl, John C.; Mumma, Michael J. (Goddard Space Flight Center, Greenbelt, Md.). J. Chem. Phys.; 57: No. 5, 1891-5(1 Sep 1972).

Dissociative processes in molecules excited by electron impact can be studied by examining the angular distributions of dissociation fragments. Previous theoretical calculations of angular distributions have not included the effects of linear momentum transfer in the collision process. Such effects can be significant. A procedure, valid near threshold, is developed which permits the calculation of laboratory angular and velocity distributions. The results are applied with some success to dissociative ionization in molecular hydrogen. (auth)

48848 RADIATIVE RECOMBINATION OF ATOMS AS A RESONANCE-SCATTERING PROCESS. Carrington, Tucker (York Univ., Toronto). J. Chem. Phys.; 57: No. 5, 2033-7(1 Sep 1972).

The rate coefficient for two-body radiative recombination of atoms via the "crossing" of two potential curves is derived from the Breit–Wigner cross section for resonance scattering. The level widths, the natural parameters in terms of which to describe the scattering, are the starting point. The development allows one to investigate the dependence of the recombination rate on level widths and on the position of the dissociation limit of the outer potential curve relative to the rotational structure in the inner curve. It also provides a unique definition of the probability of radiative recombination per collision. (auth)

48849 BALLISTIC MECHANISM FOR VIBRATIONAL AND ROTATIONAL ENERGY TRANSFER IN Ar + CsI COLLISIONS. Loesch, H. J.; Herschbach, D. R. (Harvard Univ., Cambridge, Mass.). J. Chem. Phys.; 57: No. 5, 2038-50(1 Sep 1972).

Velocity and angular distributions were measured for scattering from crossed beams of Ar and CsI. The Ar beam was generated by the seeded-nozzle technique, using dilution with H_2 and varying the source temperature to obtain collision energies from 0.35 to 1.1 eV. The CsI beam was generated by thermal effusion at ~1000°K. Mass spectrometric analysis of the scattered CsI was carried out for both the parent CsI^+ ion and the fragment Cs^+ ion. The velocity spectra for Cs^+ show very pronounced peaks located near the ArCsI centroid. These peaks correspond to an extremely inelastic, "ballistic" process in which most of the initial relative translational energy goes into vibrational or rotational excitation. The velocity spectra for CsI^+ agree with Cs^+ in the elastic region but show almost no inelastic peak. This is consistent with the ballistic process, since highly "vibrationally" excited molecules are likely to be readily fragmented by electron bombardment. Kinematic analysis of the data indicates the fractional energy transfer $\Delta E/E > 90\%$ for the wide-angle inelastic scattering. The energy transfer decreases appreciably at smaller angles. The intensity of inelastic scattering into the forward hemisphere is roughly a factor of 2 larger than that into the backward hemisphere. The angular distribution of elastic scattering also has an unusual shape, with a pronounced minimum apparently due to attenuation by the inelastic scattering. The total cross section for ballistic energy transfer is about 20 Å^2. An optical model treatment shows the angular distributions are consistent with an inelastic transition probability that is low for small impact parameters and high for large impact parameters. Vibrational and rotational energy transfer are shown to be comparable for impact parameters that give the maximum transition probability, near $b \sim 2.7 \pm 0.7$ Å. At smaller b the excitation is primarily vibrational, at larger b primarily rotational. The $\Delta E/E$ predicted for a completely impulsive hard-sphere collision (determined solely by mass ratios) is only 40%. This suggests the ballistic mechanism differs qualitatively from Landau–Teller; it may involve a resonant or quasi-bound ArCsI complex. (auth)

48850 PHYSICAL INTERPRETATION OF GLORY UNDULATIONS IN SCATTERING CROSS SECTIONS. Greene, E. F.; Mason, E. A. (Brown Univ., Providence, R. I.). J. Chem. Phys.; 57: No. 5, 2065-9(1 Sep 1972).

The physical interpretation of the spacing of glory undulations as a function of energy is approached through the interpretation of the coefficients in a semiclassical expansion in the relative kinetic energy of the form $(a_1 - A_1K^{-1} + A_2K^{-2} + \cdots)$. The coefficient a_1 measures the area of the intermolecular potential well along the glory trajectory, whereas A_1 and A_2 give measures of the square and cube of the well, respectively. Examples are given for square-well and Lennard-Jones (n, 6) potentials. Measured values of the spacings of the glory oscillations for a system do not give as specific information on the potential as has sometimes been conjectured, but the information obtainable is quite definite and can be used to put constraints on the form of the potential for that system. (auth)

48851 SCATTERING OF FAST POTASSIUM IONS BY HELIUM, NEON, AND ARGON. Amdur, I.; Jordan, J. E.; Chien, K.-R.; (and others) (Massachusetts Inst. of Tech., Cambridge). J. Chem. Phys.; 57: No. 5, 2117-21(1 Sep 1972).

A new apparatus was designed and built, and measurements were made of the effective total cross sections for the scattering of potassium ions with energies between 150 and 2350 eV by room temperature helium, neon, and argon. The repulsive interaction potentials were deduced from the measured cross sections with two different representations of the potential, the inverse power, and the exponential. The results are as follows (energies are in electron volts and distances are in angstroms): K^+–He, $V(r) = 2.70/r^{6.22}$, $V(r) = 2200 \exp(-4.56r)$, and $1.18 \le r \le 1.83$; for K^+–Ne, $V(r) = 122/r^{7.64}$, $V(r) = 7850 \exp(-4.79r)$, and $1.42 \le r \le 2.02$; for K^+–Ar, $V(r) = 667/r^{7.78}$, $V(r) = 8900 \exp(-3.96r)$, and $1.76 \le r \le 2.47$. These results compare very favorably with other experimental potentials reported recently but are in sharp disagreement with some earlier results. They also disagree with reported potentials that were calculated theoretically, except for the case of K^+–Ar where the agreement between theory and experiment is remarkably good. The potentials are also compared to those determined from measurements of the scattering of argon by the same three gases, and the effect on the potential of the additional nuclear charge is discussed. (auth)

48852 EXTRACTION OF SCATTERING INFORMATION FROM BOUND-STATE CONFIGURATION-INTERACTION COMPUTATIONS: ELASTIC ELECTRON–HYDROGEN SCATTERING. Murtaugh, Terence S. (Harvard Univ., Cambridge, Mass.); Reinhardt, William P. J. Chem. Phys.; 57: No. 5, 2129-34(1 Sep 1972).

Using the fact that for complex energies the Fredholm determinant, D(z), for the partial wave Lippmann–Schwinger equation may be constructed using only square integrable (L^2) basic functions, electron–hydrogen-atom elastic phase shifts are computed using input generated from a standard bound-state Hylleraas program. The necessary numerical analytic continuation needed to take the $z = E + i\epsilon$ limit is performed by the pointwise rational-fraction method and yields the phase shift over a continuous range of energies from a single major computational step. No integrals over non-L^2 functions are needed for the computation. (auth)

48853 COLLISION DYNAMICS OF THREE INTERACTING ATOMS: THE FADDEEV EQUATIONS. Micha, David A. (Univ. of Florida, Gainesville). J. Chem. Phys.; 57: No. 5, 2184-92 (1 Sep 1972).

An approach to atom–diatom collisions is developed in terms of sums of spin–dependent atomic pair interactions. Elastic, inelastic, atom-exchange, and dissociative collisions are simultaneously considered within the Faddeev formalism, neglecting electronic excitation or ionization. These events may be described as successions of pair encounters where atomic spins are coupled in singlet or triplet states. At high energies a justification is given for the "spectator stripping" model for the reaction $A + BC \rightarrow AB + C$ and the corresponding probability amplitude is obtained. It is also found that the first correction to this model involves a "displacement" mechanism and an effective interaction between A and C. (auth)

48854 INERT GAS POTENTIALS FOR MIXED INTERACTIONS. Brown, Nancy J.; Munn, Robert J. (Univ. of Maryland, College Park). J. Chem. Phys.; 57: No. 5, 2216-18(1 Sep 1972).

The potential $V(r) = \epsilon\phi(r/\sigma)$ proposed by Munn (J. Chem. Phys., 40: 1439(1964)) and a standard JWKB approach were used to calculate differential cross sections for the inert gas systems Ne + Ar, Ne + Kr, Ne + Xe, Ar + Kr, and Ar + Xe. Comparison of the results with experimental values shows that the gross rainbow structure is reproduced. An examination of high-frequency oscillations shows substantial disagreement although discrepancies can be detected. When the parameters ϵ and r_m associated with the Munn potential are compared with those obtained using a Lennard-Jones potential or a Schlier potential, agreement is at best fair. (A.G.W.)

48855 ATOM–ATOM AND ATOM-ION COLLISIONS. 3. COLLISIONS INVOLVING EXCITATION TRANSFER, SPIN EXCHANGE OR DEPOLARIZATION, WITHOUT INTERNAL ENERGY CHANGE. Massey, H. (University Coll., London). Contemp. Phys.; 13: No. 4, 375-92(Jul 1972).

Three types of collisions between atomic systems in which no change of internal energy takes place are considered. These are collisions in which transfer of excitation occurs between two similar atoms, spin-exchange collisions, and collisions in which the direction but not the magnitude of the orbital angular momentum of an excited atom is changed on impact. An account is given of the theory of these processes in relation to that for other processes, elastic scattering and symmetrical charge exchange, in which no change of internal energy occurs. Methods for measuring the relevant cross section are described. These make use of optical pumping and nuclear magnetic resonance techniques. Comparison is made between observed and calculated cross sections. (auth)

48856 DISPERSION INTERACTION OF NEUTRAL ATOMS. Chibisov, M. I. Opt. Spectrosc. (USSR) (Engl. Transl.); 32: No. 1, 1-3(Jan 1972).

Translated from Opt. Spektrosk.; 32: No. 1, 3-9(Jan 1972).

Calculations were made for the long-range polarization contribution to the splitting of levels, which is responsible for the excitation transfer at collisions of two hydrogen atoms in the ground and the first excited states ($n = 2$). The polarization contribution is of the same order as that of the exchange. (auth)

48857 EXCITATION OF THE ELECTRONIC LEVELS OF THE NITROGEN MOLECULE BY ELECTRON IMPACT. Polak, L. S.; Slovetskii, D. I. (Inst. of Petrochemical Synthesis, Moscow). High Energy Chem. (USSR) (Engl. Transl.); 6: No. 1, 72-3(1972).

Translated from Khim. Vys. Energ.; 6: No. 1, 87-8(1972).

A semi-empirical formula for the cross section for excitation of vibrational levels is used to obtain excitation functions for different electronic states of the nitrogen molecule by electron impact. The validity of the formula is confirmed by available experimental results. To obtain excitation functions of the other electronic states, relative excitation functions measured by different methods were used. With the exception of the $A^3\Sigma_u^+$ state, the errors in the values given are estimated at ±30% and are mainly due to the extrapolation of the angular distributions of the cross sections to angles greater than 90°. (A.G.W.)

48858 LOW-ENERGY ION–MOLECULE SCATTERING APPARATUS. Arikawa, Tatsuo; Mochizuki, Takayasu; Miyamoto, Goro (Tokyo Univ.). Jap. J. Appl. Phys.; 11: 1212(1972).

A crossed-beam apparatus for the study of ion–molecule scattering is described briefly. A stainless steel main chamber contains an ion source, a molecular-beam source, and a detection system. The ion source provides a mass-selected ion beam of energies from several tens of eV down to 1 eV or less. The detection system consists of angle-defining slits, an energy analyzer of a stopping-potential type, and an rf quadrupole mass filter. A figure showing elastic differential cross sections for $He^+ + CH_4$ is included as a typical example of the results obtained. (A.G.W.)

48859 DIFFERENTIAL CROSS SECTIONS FOR ELASTIC SCATTERING OF LOW ENERGY ELECTRONS BY SODIUM. Gehenn, W.; Reichert, E. (Univ., Mainz). Z. Phys.; 254: No. 1, 28-34(1972). (In German).

The elastic differential cross section of electrons scattered by sodium was measured over the angular range from 25 to 150° and with electron energies between 0.5 and 20 eV. The agreement of the results with recent theoretical values is good. (auth)

48860 SHAPE OF RESONANCE LINES IN THE SPECTRA OF ELECTRONS EJECTED FROM ATOMS BY FAST PARTICLES. Balashov, V. V.; Lipovetsky, S. S.; Senashenko, V. S. (Moscow State Univ.). Phys. Lett.; 40A: No. 5, 389-90(14 Aug 1972).

A general theoretical description of variations in the shape of resonance lines in the spectra of ejected electrons is proposed. Calculations are made for the $(2s,2p)^1P^{(-)}$ resonance in He excited by fast electrons. (auth)

48861 FORMATION OF $ArNO^+$, $KrNO^+$, AND OTHER IONS IN REACTIONS OF EXCITED ATOMS WITH NITRIC OXIDE MOLECULES. Kupriyanov, S. E.; Verbovskaya, G. V. High Energy Chem. (USSR) (Engl. Transl.): 6: No. 1, 90-1(1972).

Translated from Khim. Vys. Energ.; 6: No. 1, 102-3(1972).

Processes leading to formation of ions in binary mixtures of NO with noble gases were studied. In the cases of Ar and Kr, it was found that $ArNO^+$ and $KrNO^+$ were formed in associative ionization reactions and NO^+ in Penning ionization reactions. In the cases of He, Ne, and Xe, no ions of the type XNO^+ were detected; only Penning ionization was observed. Highly excited long-lived nitrogen and oxygen atoms, presumably formed as a result of dissociation of nitric oxide in collisions with electrons, were observed. These highly excited atoms reacted with nitric oxide molecules to form N^+ and O^+. (A.G.W.)

48862 EXCITED-ION LIFETIMES USING PENNING-IONIZING COLLISIONS. Parks, W. F.; Schearer, L. D. (Univ. of Missouri, Rolla). Phys. Rev. Lett.; 29: No. 9, 531-3(28 Aug 1972).

It is shown that in the Penning-ionizing collision $He(2^3S_1) + X \rightarrow He(1^1S_0) + (X^+)^* + e$ the precession of the He^m spin at its Larmor frequency forces the J polarization of the Penning ion to rotate at the same frequency but shifted in phase. The tangent of the phase shift is proportional to the lifetime of the ionic state and presents a unique method for measuring excited-ion lifetimes. (auth)

48863 EVIDENCE FOR DIFFERENT INTERACTION POTENTIALS FOR ^4He–^4He AND ^3He–^3He FROM SCATTERING CROSS-SECTION MEASUREMENTS. Bennewitz, H. G.; Busse, H.; Dohmann, H. D.; Oates, D. E.; Schrader, W. (Univ., Bonn). Phys. Rev. Lett.; 29: No. 9, 533-6(28 Aug 1972).

By means of low-energy cross-section measurements on ^3He–^3He, an interatomic potential was derived, which has a minimum 3.4% deeper than that of ^4He–^4He. It is demonstrated that the difference in the potentials is significant. The atomic-mass polarization effect is proposed as a possible explanation for the different potentials. (auth)

48864 RESONANCE BREMSSTRAHLUNG AND ABSORPTION OF PHOTONS. Buimistrov, V. M. Ukr. Fiz. Zh. (Russ. Ed.); 17: No. 4, 640-8(Apr 1972). (In Russian).

Cross sections of bremsstrahlung and absorption of photons were calculated in the Born approximation for electron–ion scattering. In constrast to the ordinary one-particle formulation of the problem when electron scattering is considered in specified ion external fields and when the Hamiltonian contains only the incident-electron coordinates, a multiparticle problem was solved. In the multiparticle problem the Hamiltonian of the system contains, besides kinetic energy of the incident electron and its interactions with the ion and electromagnetic field, the Hamiltonian of the ion and interaction of bound electrons with the electromagnetic field. Such a formulation of the problem resulted in the appearance of resonance dependence of the cross section of bremsstrahlung and inverse bremsstrahlung on the electromagnetic-field frequency. Near resonance frequency the cross-section value is considerably higher than that which results from the solution of the one-particle problem. It is also noted that, when being scattered by an ion, the electron may acquire energy that is higher or lower than the photon energy by the value of electron excitation of the ion. Under certain conditions, the cross section of such a process may be greater than the ordinary inverse bremsstrahlung cross sections. (auth)

48865 APPLICABILITY OF THREE-TERM MODEL TO DESCRIBE STRUCTURE OF EXCITATION CROSS SECTIONS FOR ION–ATOM COLLISIONS. Krivskii, I. Yu.; Baletskaya, M. V.; Pop, S. S.; Zapesochnyi, I. P. (Uzhgorod State Univ., USSR). Ukr. Fiz. Zh. (Russ. Ed.); 17: No. 4, 536-9(Apr 1972). (In Russian).

A three-term model is used to describe quantitatively the excitation cross sections of K^+ ions in collisions with He, Ne, and Ar atoms. It is shown that, despite the presence of a clearly pronounced structure in the probability curves, the theoretical structures have no peculiarities and such a model does not explain the structure of experimental excitation cross sections. (auth)

Atomic Theory

Refer also to abstract 49133.

48866 SPIN REARRANGEMENT OF ATOMS IN STRONG MAGNETIC FIELDS. Labzowskii, L. N.; Lozovik, Yu. E. (Inst. of Spectroscopy, Moscow). Phys. Lett.; 40A: No. 4, 281-2(31 Jul 1972).

The process of spin rearrangement of the ground state of an atom in a strong magnetic field is discussed. This rearrangement leads to increasing the spin of an atom. Estimates are made for the helium atom and for a heavy atom in the Thomas–Fermi approximation. (auth)

48867 SUMMATION OF FEYNMAN ATOMIC DIAGRAMS WITH SIMPLE DENOMINATORS. I. Ivanov, L. N. Opt. Spectrosc. (USSR) (Engl. Transl.)· 32: No. 1, 107-8(Jan 1972).

Translated from Opt. Spektrosk.; 32: No. 1, 210-12(Jan 1972).

Calculations of the energy shifts and matrix elements of operators for the ground and first excited states of atoms with an incomplete $n = 2$ shell indicate that a special role in the total Coulombic interelectron interaction perturbation series is played by so-called terms with simple denominators. A technique for summation of these terms is illustrated by the example of calculation of the first two terms of a new rearranged series for the energy of the ground state of He. The technique can be extended to many-electron atoms. (A.G.W.)

48868 NOTE ON VIRTUAL ORBITALS. Lunell, Sten (Uppsala Univ.). Chem. Phys. Lett.; 15: No. 1, 27-30(15 Jul 1972).

A modified Fock operator, having ''virtual'' eigenvalues and eigenvectors closely resembling one-electron excitations, is derived from a variational method for excited states. A numerical illustration on the He atom is given. (auth)

48869 CUSP CONDITIONS IN EXTENDED SCF METHODS. Lunell, Sten (Uppsala Univ.). Chem. Phys. Lett.; 15: No. 1, 31-3(15 Jul 1972).

It is shown that the cusp conditions for the ordinary Hartree–Fock orbitals are not applicable in extended self-consistent-field methods, contrary to what has been stated in the literature. The correct cusp condition for a singlet state of a two-electron atom is given. (auth)

PHYSICS (ELECTROFLUID AND MAGNETOFLUID)

48870 (JPRS-56500) IONIZATION AND RECOMBINATION FRONTS IN AN ELECTROMAGNETIC FIELD. Barmin, A. A.; Kulikovskii, A. G. Translated from Gidromekhanika; 5: 5-31 (1971). 31p. NTIS.

The results of works devoted to the study of ionization and recombination fronts in a gas located in an electromagnetic field are surveyed. It also considers solutions of the simplest problems of flows containing such fronts. (auth)

48871 HYDROMAGNETIC BOUNDARY LAYER FLOW AROUND AN OSCILLATING AXISYMMETRIC BODY. Mohanty, H. K. (Indian Inst. of Tech., Kharagpur). Appl. Sci. Res. (The Hague); 26: No. 3-4, 272-84(Jun 1972).

Boundary layer flow due to rotational oscillations of an axisymmetric body in the presence of a constant magnetic field is analyzed by a process of successive approximations. The induced steady flow is confined only to the meridian place. The effect of the magnetic field is to decrease this steady flow. (auth)

48872 KINEMATIC PROPERTIES OF PSEUDOSTATIONARY MAGNETOGASDYNAMIC FLOWS. Purushotham, G.; Madhusudan (Nagarjunasagar Engineering Coll., Hyderabad, India. Agarwal Evening Science Coll., Hyderabad, India). Tensor; 23: No. 2, 199-205(May 1972).

An attempt is made to study the geometry of the vortexline in pseudostationary magnetogasdynamic flows. Considering the flow parameters as a homogeneous function of zero degree in three spatial variables and time, the basic governing equations are transformed into pseudostationary form. The geometry of a vortex line is defined and, using this, the kinematic and kinetic properties of the flows are studied. Finally, the Beltrami streakline velocity vector is characterized and the constitutive equations are obtained. Complex-lamellar flows are considered, and it is proved that the vortex lines can be geodesics on Beltrami surfaces. (M.H.R.)

48873 DERIVATION OF THE DISCONTINUITY CONDITIONS ACROSS A MAGNETOGASDYNAMIC SHOCK SURFACE. Tembharey, D. J.; Sachdeva, S. K. (D. B. Coll. of Science, Gondia, India. Government Coll., Balaghat, India). Tensor; 23: No. 2, 240-2(May 1972).

A. Jeffrey [Z. angew Math. Phys., 15: 68-71(1964)] has given a simple derivation of the discontinuity conditions across contact discontinuities, shocks, and phase fronts occurring in ordinary fluid dynamics. It makes direct use of the properties of basic equations expressed in conservation form to give a unified treatment. By expressing the basic equations in the divergence form and making use of the Gaussian divergence theorem, the generalized Rankine–Hugoniot relations were obtained in the unified form. It is shown here, that, as in the case of nondissipative hydromagnetic flows, the basic equations of magnetohydrodynamics with finite resistivity, viscosity, and thermal conductivity can also be expressed in the divergence form and, consequently, the jump relations across a magnetogasdynamic shock surface can be obtained with the help of the generalized Rankine–Hugoniot relations in the unified form. (M.H.R.)

48874 ISOMETRIC MOTION IN RELATIVISTIC MAGNETOHYDRODYNAMICS. Ciubotariu, C. D. (Polytechnic Inst. of Iasi). Phys. Lett.; 40A: No. 5, 369-70(14 Aug 1972).

It is shown that if the flow of a plasma coupled to a frozen-in magnetic field is isometric, the velocity field, the vorticity tensor, and the four-vector magnetic field are invariant under the group of motions. A generalization of Ferraro's theorem of isorotation and of the Bernoulli's theorem for force-free fluids is found. (auth)

48875 MOTION OF PERFECTLY CONDUCTING FLUIDS PAST A THIN BODY IN THE HYPOTHESIS OF OBLIQUE FIELDS. Dragos, L. (Facultatea de Matematica-Mecanica, Bucharest). Stud. Cercet. Mat.; 24: No. 2, 159-71(1972). (In Rumanian).

The problem of the motion of incompressible and perfectly conducting fluids past a thin body is studied, in the case of oblique fields in order to obtain practical conclusions with respect to the influence of the magnetic field upon the lift. The most important conclusions are shown. For small values of the parameter A(0.1 to 0.5) and for high values of the same parameter (6.0 to 10.0) the lift decreases as the angle formed by the external induction with the velocity of the undisturbed fluid increases, and it reaches a minimum value in the case of the orthogonal fields; if $0.5 < A < 4.0$ the situation is the inverse. For a certain angle of the induction the lift decreases (from infinity) as the parameter A increases (from zero), reaches a minimum value which is situated under the conventional value, then increases again, tending asymptotically toward the conventional value. The lift is not dependent (at least in the case of the plate) upon the manner in which the Kutta–Joukowsky condition is imposed. (auth)

48876 MOTION OF COMPRESSIBLE AND PERFECTLY CONDUCTING FLUIDS PAST A THIN BODY. Dragos, L. (Univ., Bucharest). Stud. Cercet. Mat.; 24: No. 2, 173-85(1972). (In Rumanian).

A simplified solution is given for a problem considered previously and conclusions are deduced with regard to the lift. The characteristic values of the lift are shown in the elliptic–hyperbolic case, while the characteristic values of the relative lift are shown in the double hyperbolic case. In the elliptic–hyperbolic case the lift is compared with the conventional value for the incompressible fluid and, in the double hyperbolic case, with the conventional value corresponding to the compressible fluid. (auth)

PHYSICS (HIGH-ENERGY)

Particle Interactions and Properties (Experimental)

Refer also to abstracts 48494, 48495, 48945, 48965, and 49295.

Electromagnetic

Refer also to abstracts 48127, 48972, and 49158.

48877 (CONF-710816–20) BUBBLE CHAMBER STUDY OF ω-MESON PHOTOPRODUCTION WITH POLARIZED PHOTONS AT 9.3 GeV. Ballam, J.; Chadwick, G. B. (Stanford Linear Accelerator Center, Calif.); Bingham, H. H. (California Univ., Berkeley. Lawrence Radiation Lab.). 1971. 14p. Dep. NTIS.

From International symposium on electron and photon interactions at high energies; Ithaca, N. Y. (23 Aug 1971).

Preliminary results are presented for ω-meson production and decay in the reaction $\gamma p \rightarrow p\omega$, based on a 650,000 picture exposure of the LRL-SLAC 82″ hydrogen bubble chamber to the monochromatic linearly polarized photon beam at SLAC. Cross sections, angular distributions are presented, the production mechanism is analyzed in terms of t channel exchanges, and these results are compared with the measurements at lower energies. It is found that the total ω-production cross section at 9.3 GeV is 2.0 ± 0.25 μb. P_σ is 0.97 ± 0.2, implying that natural parity exchange dominates the production mechanism. Parameterizing the natural exchange part as $d\sigma_N/dt(\omega) \sim B_N e A_N t$ it is found that $B_N = 17.3 \pm 3.5\ \mu b/GeV^2$ and $A_N = 9.0 \pm 1.6\ GeV^{-2}$. An overall fit to the data at 2.8, 4.7 and 9.3 GeV shows that the production mechanism is compatible with being made up of a diffractive part like the process $\gamma p \rightarrow p\rho^0$ and an OPE part. (auth)

48878 (CONF-710816–21) STUDY OF THE CHANNEL $\gamma\gamma p \rightarrow p\pi^+\pi^-$ USING A LINEARLY POLARIZED PHOTON BEAM OF ENERGY 9.3 GeV. Ballam, J.; Chadwick, G. B. (Stanford Linear Accelerator Center, Calif.); Bingham, H. H. (California Univ., Berkeley. Lawrence Radiation Lab.). 1971. 23p. Dep. NTIS.

From International symposium on electron and photon interactions at high energies; Ithaca, N. Y. (23 Aug 1971).

An analysis of ρ^0 and Δ^{++} production in the channel $\gamma p \rightarrow p\pi^+\pi^-$ is presented. Using the Soding model a ρ^0 cross section of 13.1 ± 0.5 μb and a forward differential cross section of 8 ± 8 $\mu b/GeV^2$ are obtained. The Δ^{++} cross section is 0.3 ± 0.06 μb. The parity asymmetry of the ρ is found to be 1.0 ± 0.09 indicating dominant natural parity exchange. A study of the ρ^0 decay distribution shows that ρ^0 production is consistent with s-channel helicity conservation at the γp vertex for $|t| < 0.8\ GeV^2$. (auth)

48879 (COO–1112–93) PRECISION MEASUREMENT OF THE ANOMALOUS MAGNETIC MOMENT OF THE FREE ELECTRON. Wesley, John Carl (Michigan Univ., Ann Arbor. Dept. of Physics). Dec 1970. 171p. Dep. NTIS.

Thesis.

An experiment is described in which the g-factor is measured by direct observation of the spin precession of polarized electrons in a magnetic field. (J.F.P.)

48880 (COO–2114-4) ELEMENTARY PARTICLE AND HIGH ENERGY PHENOMENA. Progress Report, September 1, 1971–September 1, 1972. Nauenberg, Uriel; Bartlett, David (Colorado Univ., Boulder. Dept. of Physics and Astrophysics). [nd]. Contract AT(11-1)-2114. 3p. Dep. NTIS.

A summary of research on K^0 decays is presented. (J.F.P.)

48881 (DESY-72/24) π^0 ELECTROPRODUCTION AT THE FIRST RESONANCE AT MOMENTUM TRANSFERS $q^2 = 0.6$, 1., AND 1.56 GeV^2. Alder, J. C.; Brasse, F. W.; Chazelas, E.; (and others) (Deutsches Elektronen-Synchrotron, Hamburg (West Germany)). May 1972. 34p. Dep. NTIS (U. S. Sales Only).

Recent measurements on electroproduction of π^0 mesons in the region of the first pion nucleon resonance at four momentum transfers of $q^2 = 0.6$ and $q^2 = 1\ GeV^2$ are extended to $q^2 = 1.56\ GeV^2$. All the results are discussed in terms of angular coefficients and multipole amplitudes. Assuming that the angular distributions are dominated by the magnetic dipole M_{1+}, the square of the magnetic dipole amplitude and its interference terms with the multipoles E_{0+}, S_{0+}, E_{1+}, S_{1+} and M_{1-} are determined. The results are compared with theoretical models. The dependence of $|M_{1+}|^2$ on the invariant mass W at different q^2 is discussed by comparison with a standard Breit Wigner formula. (auth)

48882 (DESY-72/26) RECOIL POLARIZATION IN $K^+\Lambda$ PHOTOPRODUCTION AT 5 GeV. Vogel, G.; Burfeindt, H.; Buschhorn, G.; Heide, P.; Koetz, U.; Mess, K.-H.; Schmueser, P.; Sonne, B.; Wiik, B. H. (Deutsches Elektronen-Synchrotron, Hamburg (West Germany)). Jun 1972. 14p. Dep. NTIS (U. S. Sales Only).

The Λ polarization in the reaction $\gamma p \rightarrow K^+\Lambda$ was measured using the decay $\Lambda \rightarrow p\pi^-$ as an analyzer. It is found to be large and negative in the momentum transfer range $0.2 \leq |t| \leq 1.0\ (GeV/c)^2$. (auth)

48883 (ORNL-tr–2536) ELECTRON–PHOTON CASCADES IN LEAD AT PRIMARY ENERGIES OF 100, 200, AND 400 MeV. Brockmann, R.; Keil, P.; Knop, G.; Wucherer, P. (Bonn Univ. (West Germany). Physikalisches Institut). Translated for Oak Ridge National Lab., Tenn., from Z. Phys.; 243: 464-79 (1971). 15p. Dep. NTIS.

Electron-initiated showers in compact lead plates at primary energies of 100, 200 and 400 MeV were measured by means of a propane bubble chamber. Cut-off energies of the shower electrons were measured from 1.5 to 7.5 MeV by the range in propane. The widespread range distribution was related to energy by a Monte Carlo calculation. The results are compared with shower calculations of Nagel. The electron numbers show good agreement at depths between 2 and 15 rad length. Radial and angular distributions agree also but cannot be measured with the same precision as the numbers. (auth)

48884 COMPARISON OF THE INCLUSIVE π^- DISTRIBUTIONS FROM γp, K^+p, AND pp COLLISIONS. Swanson, William P. (Stanford Univ., Calif.); Ko, Winston; Lander, Richard L.; (and others). Phys. Rev., D; 6: No. 1, 170-3(1 Jul 1972).

The inclusive reactions $\gamma p \rightarrow \pi^-$ + anything, $K^+p \rightarrow \pi^-$ + anything, and $pp \rightarrow \pi^-$ + anything are compared for small π^- laboratory momenta. Their relative shapes and magnitudes are discussed in detail and a theoretical interpretation of these characteristics is presented. (auth)

48885 TELECOMMUNICATIONS WITH MUON BEAMS. Arnold, Richard C. (Argonne National Lab., Ill.). Science; 177: No. 4044, 163-4(14 Jul 1972).

The properties of well collimated beams of muons with energies in the range of 10^9 electron volts may be suited to some specialized needs in telecommunications. A demonstration of muon telecommunications was carried out at Argonne National Laboratory. (auth)

48886 RECOIL POLARIZATION IN $K^+\Lambda$ PHOTOPRODUCTION AT 5 GeV. Vogel, G.; Burfeindt, H.; Buschhorn, G.; (and others) (Deutsches Elektronen-Synchrotron, Hamburg. Univ., Hamburg). Phys. Lett.; 40B: No. 4, 513-16(24 Jul 1972).

The Λ polarization in the reaction $\gamma p \rightarrow K^+\Lambda$ was measured using the decay $\Lambda \rightarrow p\pi^-$ as an analyzer. It is found to be large and negative in the momentum transfer range $0.2 \leq |t| \leq 1.0\ (GeV/c)^2$. (auth)

48887 PHOTON CONSCIOUSNESS: FACT OR FANCY. Woodward, James F.; de Klerk, Andre; Kahler, Gail; (and others) (Univ. of Denver). Found. Phys.; 2: No. 2-3, 241-4(Apr 1972).

An experiment designed to test the highly speculative hypothesis of photon consciousness was executed. It was found that, within the accuracy attainable with the apparatus, there is no empirical justification for the hypothesis. (auth)

Weak

Refer also to abstract 49112.

48888 (CERN–71-13(Add.)) SYSTEMATICS OF EXTRANUCLEAR HADRON CASCADES IN SHIELDS. Barbier, M.; Hunter, R. (European Organization for Nuclear Research, Geneva (Switzerland)). [nd]. 7p. Dep. NTIS (U. S. Sales Only).

The muon spectrum resulting from pion decay in flight was integrated to obtain the numbers of muons with energies in excess of a given value. The spectrum and numbers of neutrinos emitted in the same process were also calculated. The high energy tails of the muon and neutrino spectra are given in the case where the incident particle generating the cascade is a proton rather than a pion. (J.F.P.)

48889 (COO–3539-1) EXPERIMENTAL INVESTIGATION OF PION DECAYS AT THE LOS ALAMOS MESON PHYSICS FACILITY. Technical Progress Report, September 1971–August 1973. Auerbach, L. B.; Highland, V. L.; McFarlane, W. K. (Temple Univ., Philadelphia, Pa. Dept. of Physics). 1971. Contract AT(11-1)-3539. 27p. Dep. NTIS.

Design and construction of apparatus for the pion beta decay experiment is proceeding with a target date of June 1973 for preliminary runs. (auth)

48890 (LBL–950) MUON DEPOLARIZATION AND THE CHEMISTRY OF MUONIUM IN LIQUIDS. Brewer, Jesse H. (California Univ., Berkeley. Lawrence Berkeley Lab.). Jun 1972. Contract W-7405-eng-48. 106p. Dep. NTIS.

Thesis.

Polarized positive muons are stopped in liquids containing dissolved reagents. Their polarization is measured by observing positrons from the asymmetric decay as the muon spins precess in a magnetic field. As the reagent concentration is varied, the apparent initial magnitude and direction (phase) of the polarization change markedly, due to the "muonium mechanism": muons form free muonium and are depolarized in a fraction of a nanosecond via the hyperfine interaction unless the muonium reacts chemically in even shorter times to place the muon in a diamagnetic compound. The observed dependence of the magnitude and phase of the polarization upon reagent concentration confirms the validity of this model and allows extraction of chemical rate constants for fast reactions of muonium (chemically a light isotope of atomic hydrogen). A more complicated situation is also observed, in which muonium reacts to place the muon in a radical compound, where further depolarization takes place via the hyperfine interaction with the unpaired electron. The theory is expanded to include such processes. (auth)

48891 TEST OF ΔS = ΔQ IN THE TIME DISTRIBUTION OF K^0_{l3} DECAYS. Mann, W. A. (Univ. of Massachusetts, Amherst); Kofler, R. R.; Meisner, G. W.; (and others). Phys. Rev., D; 6: No. 1, 137-46(1 Jul 1972).

The weak-interaction ΔS = ΔQ selection rule was investigated in the time distribution of leptonic decays on neutral K mesons. From a sample of approximately 20,000 visible K mesons produced in the reaction in the BNL 30-in. liquid-hydrogen bubble chamber the following decays were identified: $K \to \pi^\pm e^\mp \nu$ (92 events); $K \to \pi^\pm \mu^\mp \nu$ (24 events); $K \to \pi^\pm l^\mp \nu$ (10 events); and $K \to \pi l \nu$, $K \to \pi^+\pi^-\gamma$ (72 events). A maximum-likelihood determination of the amplitude ratio is $x = A(\Delta S = -\Delta Q)/A(\Delta S = +\Delta Q)$. Combining all the charge-identified leptonic decays, the best result obtained is Rex = 0.26 (+0.10, –0.14) and Imx = 0.21(+0.15, –0.12). The ΔS = ΔQ prediction Rex = Imx = 0 lies on the 2.4-standard-deviation contour of this result. (auth)

48892 COMPARISON OF MUON–PROTON AND ELECTRON–PROTON INELASTIC SCATTERING. Braunstein, T. J.; Lakin, W. L.; Martin, F.; Perl, M. L.; Toner, W. T.; Zipf, T. F. (Stanford Univ., Calif.). Phys. Rev., D; 6: No. 1, 106-36(1 Jul 1972).

Measurements of the differential cross section for the inelastic scattering of 12-GeV/c muons on protons are reported. These measurements cover a kinematic range of $|q^2|$ (the square of the four-momentum transferred from the lepton) up to 4.0 $(GeV/c)^2$ and of muon energy losses (ν) up to 9.0 GeV. Only the scattered muon is observed in an optical spark-chamber apparatus. The data are compared with electron–proton inelastic scattering, and analyzed in terms of possible lepton form factors and anomalous interactions. μ-p inelastic scattering is found to exhibit the same mild $|q^2|$ behavior as does e-p inelastic scattering. No experimentally significant deviation from the predictions of muon–electron universality has been found. If the ratio of muon to electron inelastic cross sections is parametrized by the form $(0.1 + |q^2|/\Lambda_D^2)^{-2}$, it is found with 97.7% confidence that $\Lambda_D > 4.1$ GeV/c. The muon–proton cross sections on the average are slightly smaller than the electron–proton cross sections. This observation is not experimentally significant because such a difference might be caused by systematic errors, but this observation is used to speculate as to the most fruitful direction for future experiments. (auth)

48893 EXPERIMENTAL TESTS OF DISCRETE SYMMETRIES IN THE DECAYS $K^\pm \to \pi^+\pi^-e^\pm\nu_e$. Beier, E. W.; Buchholz, D. A.; Mann, A. K.; (and others) (Univ. of Pennsylvania, Philadelphia). Phys. Rev. Lett.; 29: No. 8, 511-15(21 Aug 1972).

Tests of the discrete symmetries P, C, CP, and T are obtained through comparison of the rare decays $K^\pm \to \pi^+\pi^-e^\pm\nu_e$ (K_{e4} decays). An important outgrowth of the experiment is a direct measurement of the low-energy pion–pion relative scattering phase, $\delta_0 - \delta_1$. (auth)

48894 LIFETIME OF THE POSITIVE MUON AND A NEW VALUE FOR G_μ. Williams, Robert W.; Williams, David L. (Univ. of Washington, Seattle). Phys. Rev., D; 6: No. 3, 737-40 (1 Aug 1972).

In the course of an experiment to determine the muon magnetic moment, the mean life of the positive muon at rest was determined to be 2.200 26 ± 0.000 81 μsec. Using this value and the new muon mass as determined from the magnetic moment, the weak-interaction coupling constant in muon decay is found to be $G_\mu = (1.434\ 81 \pm 0.000\ 26) \times 10^{-49}$ erg cm^3. (auth)

Strong (Baryon-induced)

Refer also to abstracts 49066 and 49333.

48895 (ANL/HEP–7225) CHARGED PARTICLE MULTIPLICITY DISTRIBUTION FROM 200 GeV pp INTERACTIONS. Charlton, G.; Cho, Y.; Derrick, M.; (and others) (Argonne National Lab., Ill.). Jul 1972. 12p. Dep. NTIS.

From 2728 events of 205-GeV pp interactions found in 15,000 pictures taken with the 30-inch hydrogen bubble chamber at the National Accelerator Laboratory, a total cross section of 39.5 ± 1.1 mb was measured. The mean charged particle multiplicity for inelastic pp collisions was measured to be 7.65 ± 0.17. The prong distribution from 2 to 22 prongs is broader than a Poisson distribution and has a width parameter $f_2^- = \langle n_-(n_- - 1)\rangle - \langle n_-\rangle^2 = 0.95 \pm 0.21$. (auth)

48896 (COO–3065-13) APPROACH TO FACTORIZATION AND SCALING IN INCLUSIVE REACTIONS. Ferbel, T. (Rochester Univ., N. Y. Dept. of Physics and Astronomy). 1972. Contract AT(11-1)-3065. 9p. (CONF-720640–1). Dep. NTIS.

From third international conference on many-body reactions; Zakopane, Poland (20 Jun 1972).

A compilation of existing data on inclusive reactions which provide evidence for the factorization hypothesis in the "central" region of pion production at infinite beam momentum is presented. The approach to limiting behavior in the central region is consistent with that expected on the basis of the Mueller–Regge formalism. (auth)

48897 (COO–3130-TB-172) PROGRESS REPORT OF A RESEARCH PROGRAM IN EXPERIMENTAL HIGH ENERGY PHYSICS. Shapiro, Anatole M.; Lanou, Robert E. Jr. (Brown Univ., Providence, R. I. Dept. of Physics). 1 Jun 1972. Contract AT(11-1)-3130. 20p. Dep. NTIS.

Experimental research on strong interactions is summarized. A list of publications is included. (J.F.P.)

48898 (JINR–P1-6504) PROTON–NUCLEON AND COHERENT INTERACTIONS OF 67 GeV PROTONS IN NUCLEAR EMULSIONS. Alma-Ata-Dubna-Kharkov-Leningrad-Moscow (FIAN and MGU)-Tashkent-Ulan Bator Collaboration. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of High Energy). 1972. 24p. (In Russian). Dep. NTIS (U. S. Sales Only).

The data are presented on the 67-GeV inelastic proton interactions with nucleons. These data include the multiplicity and distribution over the number of charged particles, angular distributions in c.m.s. The coherent particle generation on the photoemulsion nuclei is investigated. (auth)

48899 (LBL–703) SEARCH FOR LONG-LIVED NEUTRAL PARTICLES WHICH DECAY INTO ELECTRON PAIRS. Clark, Alan R.; Elioff, T.; Field, R. C.; Frisch, H. J.; Johnson, Rolland P.; Kerth, Leroy T.; Sah, R. C.; Shen, G.; Wenzel, W. A. (California Univ., Berkeley. Lawrence Berkeley Lab.). 29 Feb 1972. Contract W-7405-eng-48. 10p. Dep. NTIS.

A search was conducted at the Bevatron for long-lived neutral particles, of mass less than the K^0 mass, which decay into e^+e^- pairs. The neutral beam was produced by proton interactions in a copper target. No evidence for particles with proper lifetimes between 10^{-10} and 10^{-6} seconds was observed. (auth)

48900 (LBL–784) INCLUSIVE REACTION $pp \to \pi^- +$ ANYTHING AT 6.6 GeV/c COMPARED TO HIGHER ENERGIES. Gellert, Eugene (California Univ., Berkeley. Lawrence Berkeley Lab.). 5 Feb 1972. Contract W-7504-eng-48. 24p. (CONF-720206–3). Dep. NTIS.

From International conference on inclusive interactions; Davis, Ca. (4 Feb 1972).

The π^- distribution from $pp \to \pi^- +$ anything at 6.6 GeV/c is studied and compared to higher energies. It is found that for $p_\perp <$ 0.6 GeV/c and Feynman's $\underline{x} < -0.4$, the laboratory differential cross section $d^2\sigma/dp_\perp dp_{||}$ is independent of energy. The structure function $\rho(x,p_\perp,s) = Ed^3\sigma/dp^3$ is found not to be energy independent and is found not to be factorizable into functions of transverse and longitudinal momentum. (auth)

48901 (ORNL-tr–2616) STUDY OF THE NUCLEON–MESON CASCADE IN SHIELDING MATERIALS. Endovitskii, V. S.; Kimmel, L. R.; Mochov, N. V.; Britvich, G. I.; Lebedev, V. N. (Gosudarstvennyi Komitet po Ispol'zovaniyu Atomnoi Energii SSSR, Serpukhov. Institut Fiziki Vysokikh Energii). Translated for Oak Ridge National Lab., Tenn., from report IFVE-ORZ–71-96. 19p. Dep. NTIS.

The characteristics of the fields of cascade particles, generated by hadron beams with high energy in the shielding materials were studied. The angular and energy distribution functions of nucleons and pions and partial functions of space-energy distribution were found as a solution for the system of cascade equations. The calculated data are compared with the experimental ones. (auth)

48902 STUDY OF $|T_z| = {}^3\!/_2$ ΔA(1238) PRODUCTION IN pp INTERACTIONS AT 6.6 GeV/c. Colton, Eugene; Kirschbaum, Alan R. (Univ. of California, Berkeley). Phys. Rev., D; 6: No. 1, 95-105(1 Jul 1972).

$|T_z| = {}^3\!/_2$ $\Delta(1238)$ systems are studied from the standpoint of direct production utilizing experimental data on the reactions $pp \to p\pi^+n$, $pp \to p\pi^+\pi^-p$, $pp \to p\pi^+\pi^-\pi^0p$, and $pp \to p\pi^+\pi^-\pi^+n$. Resonance-production total and differential cross sections are presented, in addition to the decay density-matrix elements. It is demonstrated that the experimentally defined $\Delta(1238)$ systems are not characterized solely by spin-parity ${}^3\!/_2{}^+$, and that corresponding elements of the density matrices of both $p\pi^+$ and π^-n cases generally behave in a similar manner with increasing c.m. angle. Additional detailed studies of the t-channel moments are presented for peripherally produced πN systems as a function of both c.m. angle and πN invariant mass. Dynamical differences are observed between the $p\pi^+$ and $n\pi^-$ moments for the very peripheral data. One-pion-exchange-model predictions are compared with the peripheral $p\pi^+$ moments and with several invariant-mass distributions from the $pp \to p\pi^+\pi^-p$ data. Complications arising from the presence of two $p\pi^+$ combinations in the four- and five-body final-state data are discussed. (auth)

48903 COMPARISON OF NEW DATA ON $\bar{p}p \to \pi^-\pi^+$ AND OTHER TWO MESON STATES AT 2.3 GeV/c. Fields, T. (Argonne National Lab., Ill.); Cooper, W. A.; Rhines, D. S.; Whitmore, J.; Allison, W. W. M. Phys. Lett.; 40B: No. 4, 503-6 (24 Jul 1972).

Complete angular distributions for the reactions $\bar{p}p \to \pi^-\pi^+$ and other two meson states at 2.3 GeV/c are presented. The extraordinary $\pi^-\pi^+$ angular distribution is contrasted with the other final states and the predictions of simple models. A favorable comparison is made with the qualitative features of a dual model involving high mass meson states with a strong degeneracy with respect to I-spin. (auth)

48904 ANGULAR DISTRIBUTION OF CHARGED PARTICLES PRODUCED IN pp COLLISION AT THE CERN INTERSECTING STORAGE RINGS. Babecki, J. (Inst. of Nuclear Physics, Krakow); Chylinski, Z.; Czachowska, Z.; (and others). Phys. Lett.; 40B: No. 4, 507-9(24 Jul 1972).

The angular distribution of secondary relativistic charged particles was measured at the ISR by means of nuclear emulsions. Within the c.m. angular interval from 90 to 22.6° the ln tan $(\theta_{cm}/2)$ distribution is flat. (auth)

48905 DEUTERON SPIN ALIGNMENT IN DEUTERON–PROTON SCATTERING AT 3.6 GeV/c. Bunce, Gerry Michael. Ann Arbor, Mich.; Univ. of Michigan (1971). 74p. University Microfilms Order No. 72-14,819.

Thesis.

Proton-deuteron forward scattering just beyond the diffraction peak is expected to result mostly from the D-wave of the deuteron. Recoil deuterons from scattering in this region should be strongly spin aligned. D. R. Harrington suggested a double scattering experiment to observe this alignment. Using a 3.6-GeV/c external deuteron beam from the Princeton-Pennsylvania Accelerator, deuterons were spin aligned and analyzed in two scatters off of hydrogen. Deuteron polarization, both alignment and vector polarization, from the first scatter was measured by observing the up-right and right-left asymmetry of the deuterons in the second scatter. Scattering over four-momentum transfers from $-t = .13$ to $.54$ GeV^2/c^2 was observed. The up-right asymmetry reached 67% for small momentum transfers, and went to -37% for the largest scattering angle. The right-left asymmetry was generally 25% for all angles. A calculation using the multiple scattering theory of Glauber with no free parameters gives the qualitative features of the up-right asymmetry observed, with a maximum of 90% and the same shape as the data. Close agreement is not expected, since the calculation ignores spin-orbit effects and the target proton spin and thus makes no right-left asymmetry prediction. The up-right asymmetry prediction is quite sensitive to the parameterization for the free nucleon–nucleon scattering amplitudes. Treating the nucleon amplitude slopes and real parts as free parameters, the theory was fitted to both the asymmetry data and the forward proton–deuteron cross section data at 1 GeV. Larger real parts (-70%) of the nucleon amplitudes are preferred than those reported from nucleon–nucleon scattering. The larger real parts bring the p-n cross sections found from p-d scattering into agreement with σ_{np} from neutron beam experiments and agree with multiple scattering model fits to other proton–nucleus scattering data at 1 GeV (p-He, p-C, p-O). Both the experimental results and the calculation are presented. (Diss. Abstr. Int., B)

48906 $2\pi^0$ PRODUCTION IN ANTIPROTON ANNIHILATION AT REST IN HYDROGEN. Skelly, Joseph Francis. Syracuse, N. Y.; Syracuse Univ. (1972). 221p. University Microfilms Order No. 72-20,369.

Thesis.

The annihilations of stopping antiprotons in hydrogen in which no charged particles were produced were studied using an array of massive, optical, gamma-converting spark chambers in a nearly 4π geometry. Among the photographs of events in which exactly 4, 3, or 2 gamma rays were detected, the annihilation mode $\bar{p}p \to 2\pi^0$ was identified; the branching fraction $(\bar{p}p \to 2\pi^0)/(\bar{p}p \to \text{all})$ was measured to be $5.2(1 \pm 0.2) \times 10^{-4}$. In combination with the previously known branching fraction $(\bar{p}p \to \pi^+\pi^-)/(\bar{p}p \to \text{all})$, this result indicates that some 40% of all $\bar{p}p$ annihilations at rest into 2π occur from $\bar{p}p$ atomic states of odd orbital angular momentum, providing direct evidence against the usual assumption that S atomic states predominate in all $\bar{p}p$ annihilation modes. Also the cross section for $2\pi^0$ production at low antiproton momentum, 300 ± 100 MeV/c, was measured to be $183(1 \pm 0.25)$ μb, and a highly anisotropic angular distribution of the final state π^0 was observed. Branching fractions for the following two-meson final states in $\bar{p}p$ annihilation at rest were measured: $\pi^0\eta^0$, $\pi^0\omega^0$, $2\eta^0$, and $\eta^0\omega^0$. The annihilation modes $\bar{p}p \to \pi^0\gamma$ and $\bar{p}p \to \gamma\gamma$ were searched for and not observed. An upper limit for the branching fraction $(\bar{p}p \to \pi^0\gamma)/(\bar{p}p \to \text{all})$ was estimated to be 1.1×10^{-5}. (Diss. Abstr. Int., B)

48907 VERY HIGH ENERGY STRONG INTERACTIONS. Allaby, J. V. (CERN, Geneva). AIP (Amer. Inst. Phys.) Conf. Proc.; No. 6, 67-98(1972).

From Conference on particle physics; Irvine, CA. (3 Dec 1971). See CONF-711220.

The total cross sections for hadron reactions with protons, the production and decay of negative boson resonances in pion–proton reactions, differential cross sections for elastic hadron–proton reactions at 25 and 40 GeV/c, cross sections for elastic proton–proton scattering at 15.5 to 26.8 GeV/c, and particle production cross sections in p + p interactions are reviewed. Some new results are presented. (J.F.P.)

48908 CHARGED-PARTICLE MULTIPLICITY DISTRIBUTION FROM 200-GeV pp INTERACTIONS. Charlton, G. (Argonne National Lab., Ill.); Cho, Y.; Derrick, M.; (and others). Phys. Rev. Lett.; 29: No. 8, 515-18(21 Aug 1972).

From 2728 events of 205-GeV pp interactions found in 15,000 pictures taken with the 30-in. hydrogen bubble chamber at the National Accelerator Laboratory, a total cross section of 39.5 ± 1.1 mb was measured. The mean charged-particle multiplicity for inelastic pp collisions was measured to be 7.65 ± 0.17. The prong distribution from 2 to 22 prongs is broader than a Poisson distribution and has a width parameter $f_2^- = \langle n_-(n_- - 1)\rangle - \langle n_-\rangle^2 = 0.95 \pm 0.21$. (auth)

48909 $\bar{p}p$ BACKWARD SCATTERING AND s-CHANNEL RESONANCES: UPPER LIMIT TO THE $\bar{p}p$ COUPLING OF THE S(1929) MESON. Bizzarri, R. (Univ., Rome. Istituto Nazionale di Fisica Nucleare, Rome); Guidoni, P.; Marzano, F.; (and others). Phys. Rev., D; 6: No. 1, 160-3(1 Jul 1972).

From the energy dependence of the $\bar{p}p$ and $\bar{p}n$ inelastic cross sections an upper limit to the resonant contribution in $\bar{p}p$ backward scattering for c.m. energies between 1915 and 1950 MeV is deduced. This limit is smaller than the expected contribution from diffraction scattering. The energy dependence of the 180° $\bar{p}p$ elastic cross section in this energy range cannot therefore be directly related to the formation of s-channel resonances. (auth)

48910 STUDY OF THE $\bar{p}d \to p_s\bar{p}n\pi^+\pi^-$ REACTION AT 5.55 GeV/c. Braun, H.; Fridman, A.; Gerber, J.-P.; (and others) (Centre de Recherches Nucleaires, Strasbourg). Phys. Rev., D; 6: No. 3, 767-79(1 Aug 1972).

From a 150,000-photograph exposure of the ANL 30-in. chamber a sample of events fitting the $\bar{p}d \to p_s\bar{p}n\pi^+\pi^-$ hypotheses was obtained. Part of these events result from a coherent production process while 812, which constitute the present data, are identified as having a proton spectator in the final state. The sampling procedure is verified by using some symmetry properties of the strong interactions. Based on these 812 events an estimated cross section of 1.32 ± 0.11 mb was obtained for the $\bar{p}n \to \bar{p}n\pi^+\pi^-$ reaction. A search for resonances in the $\bar{p}n\pi^+\pi^-$ final state is carried out. Copious $\bar{\Delta}^{--}(1236)$ and $\Delta^-(1236)$ resonances are produced in equal amounts, as predicted by G invariance. The reduced peripherality of the studied reaction observed when comparing it with the $pp \to pp\pi^+\pi^-$ reaction at 5.52 GeV/c is discussed. This phenomenon is not reflected in the $\bar{\Delta}$ and Δ c.m. angular distribution, the peaking of which is found to be comparable to that of the $\Delta^{++}(1236)$ produced in the $pp \to pp\pi^+\pi^-$ reaction. The production of the $\bar{\Delta}n\pi^+$ and $\Delta\bar{p}\pi^+$ final states is compared with a simplified double-Regge model in which two parameters are fitted to the experimental distributions. Using the π and ρ trajectories good agreement is obtained between the predictions of the model and the experimental data. The events obtained by excluding the $\overline{\Delta}$ and Δ from the final state and for which the $\bar{p}$ and n are required to be emitted in the forward and backward c.m. hemispheres, respectively, are studied by means of a longitudinal phase-space plot. Despite the small statistics it is shown among other things that no dominant longitudinal configuration can be assigned to these events. (auth)

Strong (Meson-induced)

Refer also to abstracts 48128, 48975, 49063, 49334, and 49469.

48911 (BNL–16974) CURRENT PROBLEMS IN EXPERIMENTAL BOSON SPECTROSCOPY. Samios, N. P. (Brookhaven National Lab., Upton, N. Y.). 1972. 28p. (CONF-720409–9). Dep. NTIS.

From third international conference on experimental meson spectroscopy; Philadelphia, PA. (28 Apr 1972).

Some of the current and more interesting problems in the field of boson spectroscopy are discussed. In particular, a review is presented concerning the multitude of reported nonstrange mesons in the 1-GeV mass region as well as a critique of published works involving K mesons in the 1- to 1.4- and 1.75-GeV mass region. Although no clear evidence for either exotics or daughters has yet to be uncovered, the importance of such searches is stressed and alternate experimental approaches are outlined. The number of viable boson SU(3) families has remained rather static over the past two years. Further verifications of such conjectures are shown to be possible from studies of electromagnetic decays of both pseudoscalar and vector mesons. Finally the possible ramifications of the new results of $\bar{p}p$ annihilations at rest are discussed. (auth)

48912 (COO–1195-235) ANNUAL PROGRESS REPORT. Wattenberg, A.; Simmons, R. O. (Illinois Univ., Urbana. Dept. of Physics). Apr 1972. Contract AT(11-1)-1195. 29p. Dep. NTIS.

A summary of research on meson-induced strong interactions is presented. A list of publications is included. (J.F.P.)

48913 (COO–1428-305) ANNUAL PROGRESS REPORT, JUNE 1, 1971–MAY 31, 1972. (Purdue Univ., Lafayette, Ind.). 1972. Contract AT(11-1)-1428. 26p. Dep. NTIS.

A summary of experimental research on strong interactions is presented. A list of publications is included. (J.F.P.)

48914 (INR-P-1400) SIX-PRONG INTERACTIONS OF π^+ MESONS WITH PROTONS AT 8 GeV/c. Bardadin-Otwinowska, Maria; Hofmokl, Tomasz; Wojcik, Wojciech; Wroblewski, Andrezej; Zieminska, Daria; Michejda, Lech; Otwinowski, Stanislaw; Sosnowski, Ryszard; Szeptycka, Maria (Institute of Nuclear Research, Warsaw (Poland)). 1972. 135p. Dep. NTIS (U. S. Sales Only).

Final results for 3678 π^+p six-prong events at 8 GeV/c are presented. Single-particle distributions are compared with the predictions of the Chan–Loskiewicz–Allison model and the phenomenological model of the F(t) function. Difference between the transverse momenta of the π^+ and π^- and between the transverse momenta of secondaries emitted forward and backward in the c.m. system are observed. Cross sections for production of the ρ^0, ρ^+, ρ^-, η^0, ω^0, X^0 and D^0 mesons and the N_{33}^{*++} and N_{33}^{*-} isobars are given, together with upper limits for some other resonances. The D^0 meson is observed in the seven-body channel in the $\eta\pi^+\pi^-$ system, with some evidence for the cascade decay $D^0 \rightarrow \delta^{\pm}\pi^{\mp} \rightarrow \eta\pi^+\pi^-$. The branching ratio $(f^0 \rightarrow 2\pi^+2\pi^-)/(f^0 \rightarrow 2\pi)$ is determined to be $(2.2^{+4.5}_{-2.2})$%. Upper limits for the decay of A mesons into $X^0\pi$ systems are quoted. The cross section for the two-body reaction $\pi^+p \rightarrow N_{33}^{*++} X^0$ is determined to be (30 ± 13) μb, from which the η^0-X^0 mixing angle is derived. Associated production of N_{33}^{*++} and ρ^0 in the six-body channel and of N_{33}^{*++}, ρ^0, and ω^0 in the seven-body channel is studied, and the cross sections for reactions involving simultaneous production of these resonances are estimated. The Goldhaber–Goldhaber–Lee–Pais effect is studied and shown to be strong in the six-body channel, especially for selected events with low energy of the pion system. (auth)

48915 (JINR-P1-6491) ANALYSIS OF EXPERIMENTAL DATA ON SECONDARY PARTICLE MULTIPLICITY IN π^-p, π^-n, AND π^-C COLLISIONS AT p = 40 GeV/c. Abdurakhimov, A. U.; Angelov, N.; Belyakov, V. A.; (and others) (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of High Energy). 1972. 16p. (In Russian). Dep. NTIS (U. S. Sales Only).

Experimental data on multiplicity of secondary charged and neutral particles in π^-p and π^-C interactions at p = 40 GeV/c are compared. The distribution of the events on secondary charged particle multiplicity in π^-p and π^-n interactions are compared with the calculations on different models and empirical formulas. Only the Wang I model and empirical formulas describe the experimental distributions. The data are obtained on the dependence of an average number of π^0-mesons on the charged particle number. The results of these data anaylsis, using the theoretical models, are discussed. (auth)

48916 (LBL–763) RECENT EXPERIMENTAL STUDIES OF THE $K\pi$ INTERACTION. Trippe, Thomas G. (California Univ., Berkeley. Lawrence Berkeley Lab.). Dec 1971. Contract W-7405-eng-48. 69p. (CONF-710653–1). Dep. NTIS.

From Summer workshop No. 1 "$\pi\pi$ and $K\pi$ interactions"; Argonne, IL. (3 Jun 1971).

Recent experimental work on $K + \pi$ scattering is reviewed. The techniques are briefly described. The compilation, comparison, and interpretation of results and the understanding of discrepancies are discussed. (J.F.P.)

48917 (LBL–787(Rev.)) A $\pi\pi$ PHASE SHIFT ANALYSIS FROM REACTIONS $\pi^+p \rightarrow \pi^+\pi^- \Delta^{++}$ AND $\pi^+p \rightarrow K^+K^- \Delta^{++}$ AT 7.1 GeV/c. Protopopescu, S. D.; Alston-Garnjost, M.; Barbaro-Galtieri, A.; Flatte, S. M.; Friedman, J. H.; Lasinski, T. A.; Lynch, G. R.; Rabin, M. S.; Solmitz, F. T. (California Univ., Berkeley. Lawrence Berkeley Lab.). Apr 1972. Contract W-7405-eng-48. 42p. (CONF-720409–10). Dep. NTIS.

From third international conference on experimental meson spectroscopy; Philadelphia, PA. (28 Apr 1972).

Results of an energy-dependent $\pi\pi$ phase shift analysis for $\pi\pi$ energies between 550 and 1150 MeV are presented. The I = 0 s wave is parametrized in terms of a 2 × 2 M-matrix coupling $\pi\pi$ and KK channels. A unique solution is obtained for this wave. (auth)

48918 (NP-19373) STUDY OF THE REACTION $K^+p \rightarrow K^0p\pi^+$ AT 2.17 AND 2.34 GeV/c. Pessard, Henri (Paris Univ. (France)). 1972. 128p. (In French). Dep. NTIS (U. S. Sales Only).

Thesis.

The reaction $K^+ + p \rightarrow K^0 + p + \pi^+$ at 2.17 to 2.34 GeV/c is studied for production of the resonances K(890) and Δ^{++}(1236). The differential cross sections and density matrix elements for decay angular distributions are found. (J.F.P.)

48919 (NP-19383) STUDY OF THE REACTIONS $\pi^-p \rightarrow K^0$ (K*890) Λ (Σ^0) AT 3.9 GeV/c. Abramovich, Milton (Paris Univ., Orsay (France). Faculte des Sciences). 1972. 166p. (In French). Dep. NTIS (U.S. Sales Only). Thesis.

The reactions $\pi^- + p \rightarrow K^0$ (K(890)) + Λ and $\pi^- + p \rightarrow K^0$ (K(890)) + Σ^0 at 3.9 GeV/c in a bubble chamber were studied. The mass distributions, total and differential cross sections, density matrix elements, lambda polarization, and a search for exotic exchange are discussed. (J.F.P.)

48920 (RHEL/R–245) K-MESON PHYSICS BELOW 5 GeV/c. Proceedings of Conference, Rutherford High Energy Laboratory, Chilton, England, 19–21 November 1971. Oades, G. C. (ed.) (Rutherford High Energy Lab., Chilton (England)). Apr 1972. 270p. (CONF-711142). UK 1.40 pound.

Fourteen papers were presented at this conference on future work in $K^{\pm}$ strong interaction physics below 5 GeV/c. Abstracts were prepared for all papers. (UK)

For abstracts of individual papers see: 48921–48927 and 49064–49070.

48921 (RHEL/R-245, pp 19-27) TRACK-SENSITIVE TARGETS AND $\bar{K}N$. Miller, David J. (University Coll., London).

From Meeting on future work in $K^{\pm}$ strong interaction physics below 5 GeV/c; Chilton, England (19 Nov 1971).

The target under test at NIMROD (Rutherford High Energy Laboratory) is described. It consists of a stainless steel frame, with plates of thin perspex clamped on either side. It is about 35 cm. high and 4 cm deep, and runs almost the full length of the 1.5 m. cryogenic bubble chamber. The H_2 in the target expands when the H_2-Ne mixture in the rest of the chamber is expanded; this is why flexible perspex walls are used. There were 150,000 expansions and 60,000 pictures achieved without any trouble. The target is provided with a separate refrigeration loop that can maintain a temperature differential with the chamber of ~1°K; this means that it will be possible to operate with pure H_2 inside and a slightly warmer mixture outside, with radiation lengths down to ~35 cm. Amongst matters discussed are interesting channels in $\bar{K}N$, and some possible experimental work. (UK)

48922 (RHEL/R-245, pp 61-86) KN AND $\bar{K}N$ TWO-BODY PHYSICS: 2 TO 5 GeV/c. Michael, C. (CERN, Geneva).

From Meeting on future work in $K^{\pm}$ strong interaction physics below 5 GeV/c; Chilton, England (19 Nov 1971).

KN and $\bar{K}N$ induced reactions in the intermediate energy region are reviewed to indicate present theoretical understanding and promising future avenues of study. Several experiments are suggested that should advance or consolidate this understanding;

these include obtaining polarization data for $K^0p \rightarrow K^+n$, $K^-p \rightarrow \bar{K}^0n$, and $K_L^0p \rightarrow K_s^0p$ and R parameter data for $K^+p \rightarrow K^+p$ and $\bar{K}N \rightarrow \Lambda\pi$ and $\Sigma^+\pi$; also precise cross section differences between $K^\pm p$ and $K^\pm n$ elastic scattering, between K and $\bar{K}$ charge exchange, and between $\bar{K}N \rightarrow \pi Y$ and $\pi \rightarrow KY$. Accurate data at a wide range of energies and fixed t to determine energy dependence and α_{eff} will also be valuable, and accurate data on a relatively complete set of observables will be necessary to ascertain s channel resonance contributions in the intermediate energy region. 20 references. (UK)

48923 (RHEL/R-245, pp 87-113) K^+p ELASTIC SCATTERING BELOW 2 GeV/c. Oades, G. C. (Rutherford High Energy Lab., Chilton, Eng.).

From meeting on future work in $K^\pm$ strong interaction physics below 5 GeV/c; Chilton, England (19 Nov 1971).

A review is presented on K^+p elastic scattering up to 2 GeV/c, summarizing the present experimental situation and indicating where further experiments would be of particular value. It is convenient to review first the region below about 0.9 GeV/c, where the nuclear scattering is basically isotropic, and then the region 0.9 to 2.0 GeV/c, where the rapid onset of a large forward peak and a much smaller backward peak are seen, these features then persisting to high energies. Some brief comments on partial wave analyses of this system are made. 27 references. (auth)

48924 (RHEL/R-245, pp 133-43) K^+p ELASTIC SCATTERING BETWEEN 430 AND 940 MeV/c. (Univ. of Birmingham, Eng. Rutherford High Energy Laboratory, Chilton, Eng.).

From Meeting on future work in $K^\pm$ strong interaction physics below 5 GeV/c; Chilton, England (19 Nov 1971).

The differential cross section for K^+p elastic scattering was measured between 430 and 940 MeV/c in a spark chamber experiment performed at the Rutherford High Energy Laboratory. The elastic cross sections deduced from the results were almost independent of momentum in the range covered. Some comments are made on the consistency (inconsistency) with other available data, in particular the measured total cross sections below 700 MeV/c. (7 references) (auth)

48925 (RHEL/R-245, pp 145-61) POSITIVE KAON PROTON ELASTIC DIFFERENTIAL CROSS-SECTIONS IN THE INTERMEDIATE MOMENTUM REGION (0.9 TO 1.9 GeV/c). (Bristol Univ., Eng. Southampton Univ., Eng. Rutherford High Energy Lab., Chilton, Eng.).

From Meeting on future work in $K^\pm$ strong interaction physics below 5 GeV/c; Chilton, England (19 Nov 1971).

The $K^+ + p$ elastic differential cross sections are studied in the region from 0.9 to 1.9 GeV/c. A lack of energy-dependent structure characteristic of the KN interactions is found. (J.F.P.)

48926 (RHEL/R-245, pp 199-231) REVIEW OF THE I = 0 STATE IN K^+N SCATTERING. Wilson, Brian C.

From Meeting on future work in $K^\pm$ strong interaction physics below 5 GeV/c; Chilton, England (19 Nov 1971).

The situation is reviewed as regards the I = 0 state of the K^+N system in the momentum range below 2 GeV/c, where the possibility of the formation of an exotic resonance, Z_0^*, was suggested by the structures in the total cross section. The data existing for this state are considered, together with what data are needed in order to resolve present phase shift ambiguities. Two basic problems encountered in the analysis of the l = 0 state, which are not met with in the l = 1 state, are discussed—first, there is no experimentally accessible pure l = 0 reaction corresponding to K^+p scattering for the l = 1 state; secondly, and arising out of the first problem, in order to obtain the appropriate elastic or charge-exchange differential cross section data it is necessary to use a D target (there is no alternative for the elastic case), or to use a neutral K^0 beam, with the associated difficulties of determining the beam momentum and the neutron background, the latter being a particular problem for the charge-exchange case where there is a neutron in the two-body final state. The main difficulties of using D as a target in order to extract K^+ data are discussed in detail. 17 references. (UK)

48927 (RHEL/R-245, pp 233-70) KN → 3 BODY (OR MORE) CHANNELS. Hirata, Allan A. (Univ. of Glasgow).

From Meeting on future work in $K^\pm$ strong interaction physics below 5 GeV/c; Chilton, England (19 Nov 1971).

Amongst matters discussed are the following: experimental situation on inelastic processes; measurements of partial cross sections (pion production in H_2 and D; free-neutron partial cross sections; isospin-O inelastic cross sections); the reaction $K^+p \rightarrow K^0\Delta^{++}$ (percentage of resonance production; production and decay angular distributions phase shift analysis); and the reaction $KN \rightarrow K^*N$ (isospin-1 $KN \rightarrow K^*N$; isospin-O$KN \rightarrow K^*N$). 12 references. (UK)

48928 SPECTRUM OF THE NEUTRAL MESON SYSTEM (X^0) IN $\pi^-p \rightarrow \pi^-pX^0$ AT 13.4 GeV/C. Thun, Rudolf Paul. Stony Brook, N. Y.; State Univ. of New York (1972). 220p. University Microfilms Order No. 72-16,973.

Thesis.

The spectrum of the neutral meson system (X^0) in $\pi^-P \rightarrow \pi^-PX^0$ was obtained at a beam momentum of 13.4 GeV/c by use of the missing mass technique. The recoil proton momentum was measured with a spectrometer consisting of wire spark chambers and large scintillators. The detected protons had kinetic energies below 220 MeV and were scattered at large angles with respect to the beam direction. The momentum of the scattered pion was measured with a magnet spectrometer set near the forward direction. The pion scattering angle was limited to values less than 100 milliradians. The minimum pion momentum was 2.5 GeV/c. The neutral spectrum shows strong π^0, ρ^0, ω^0 signals and a prominent peak at 1.280 GeV with a width of 37 MeV which is interpreted as the D^0 meson. There is some evidence of the η^0 and of a narrow peak near 1.422 GeV which may be the E^0. This evidence is of limited statistical significance. Most of the π^0 signal is correlated to N* production, that is: $\pi^-p \rightarrow \pi^-N^* \rightarrow \pi^-(p\pi^0)$. A very large fraction of the ρ^0 mesons is produced by the decay of X^- in $\pi^-p \rightarrow X^-p \rightarrow (\pi^-\rho^0)p$ where X^- lies in the A_1-A_2 region. Most ω^0 and D^0 production is uncorrelated to any decay of N* or X^- resonances. Two other X^- decay processes appear in the data, although not with great statistical accuracy. The first in $X^- \rightarrow \pi^-\pi^0$ where X^- is a peak centered at 1.710 GeV with a width of 0.125 GeV. The other is $X^- \rightarrow \pi^-\omega^0$ where X^- has a mass of 1.615 GeV and a width of 0.090 GeV. These X^- bumps are consistent with the ($\pi\pi$) and ($\pi\omega$) peaks observed in other experiments. (Diss. Abstr. Int., B)

48929 STUDY OF NONSTRANGE MESONS PRODUCED IN K^-p INTERACTIONS AT 3.9 AND 4.6 GeV/c. Aguilar-Benitez, M.; Chung, S. U.; Eisner, R. K.; Samios, N. P. (Brookhaven National Lab., Upton, N. Y.). Phys. Rev., D; 6: No. 1, 29-94(1 Jul 1972).

An investigation is presented on the production and decay properties of pseudoscalar, vector, and tensor mesons produced in association with Λ, Σ^0, and Y*(1385) from K^-p interactions at 3.9 and 4.6 GeV/c. The data have been compared with SU(3) and quark-model predictions. New measurements of the mass, width, and branching ratios of the ϕ(1019), f′(1519), and Y*(1385) resonances are given. The analysis of the η' meson favors the $J^{PC} = 0^{-+}$ classification. The properties of this well-known meson are compared with those of the previously proposed M(953) meson. An important aspect of this study is that particular emphasis has been placed on taking the background into account when we extracted resonance quantities such as the density-matrix elements. (auth)

48930 INTERFERENCE EFFECTS OF K*(890) AND K*(1420) RESONANCES WITH THE BACKGROUND. Aguilar-Benitez, M.; Chung, S. U.; Eisner, R. L. (Brookhaven National Lab., Upton, N. Y.). Phys. Rev., D; 6: No. 1, 11-28(1 Jul 1972).

A study was made of interference effects between K*(890) and K*(1420) resonances and the background as observed in the reaction $K^-p \rightarrow K^-\pi^+n$ at 3.9- and 4.6-GeV/c incident momenta, using a mass-dependent formalism which utilizes the generalized multipole moments. From this analysis the K*(890) and K*(1420) density-matrix elements were obtained in the Jackson frame which satisfy the spin-1 and spin-2 positivity conditions, respectively. The implications of the degree and the phase of the interference on the nature of the production mechanism as well as the question of whether there exists a daughter resonance near the K*(1420) are discussed. (auth)

48931 CORRELATIONS BETWEEN THE LONGITUDINAL MOMENTA OF p AND $\bar{K}^0$ IN THE INCLUSIVE REACTION $K^-p \rightarrow \bar{K}^0p$ + ANYTHING AT 10 GeV/c. (Aachen-Berlin-CERN-London-Vienna Collaboration). Phys. Lett.; 40B: No. 4, 510-12(24 Jul 1972).

The problem of how much of the correlations observed between the longitudinal momenta of the two leading particles can be explained by facts already known from single particle distributions is studied in the reaction $K^- + p \rightarrow \bar{K}^0 + p$ + anything at 10 GeV/c. It is argued that the correlation function of variables related to the momentum is strongly distorted because of the non-rectangular boundaries imposed by energy-momentum conservation. It is shown that the exponential decrease of the transverse momentum for produced pions and of the four-momentum transfer for leading particles are sufficient to describe the main features of the experimental correlation function. (auth)

48932 PRODUCTION OF NEUTRAL KAONS AND LAMBDAS FROM CHARGED KAON INTERACTIONS WITH COMPLEX NUCLEI. Banner, David Lee. Urbana, Ill., Univ. of Illinois (1972). 91p. University Microfilms Order No. 72-19,792.

Thesis.

Measurements of the cross sections for the production of neutral kaons with momenta $\lesssim 400$ MeV/c and lambdas with momenta $\lesssim 700$ MeV/c from charged kaon interactions incident at 850 MeV/c on carbon, aluminum, copper, tin, and lead were made at the Argonne National Laboratory Zero-Gradient Synchrotron. The measurements were made in order to determine which complex nuclear targets produced the best "beams" of neutral kaons, for use in an experiment to observe the decay of neutral K mesons into $\pi^+\pi^-$. The cross sections are presented, and models for fitting the data, involving $A^{1/3}$- and $A^{2/3}$-parameterizations, are discussed. The K^0 and $\overline{K}^0$ cross sections were fit about equally well with an $A^{1/3}$- and $A^{2/3}$-parameterization. Monte Carlo computer codes were written to see whether the experimental cross sections could be understood on the basis of a simple impulse approximation model. Relative cross sections computed with the Monte Carlo codes agree reasonably well, after experimental cuts were included, with the experimental cross sections for K^0 and $\overline{K}^0$ production. The agreement is not very good for Λ production, but a possible explanation for the disagreement is discussed. For a fixed-length target, 7 cm long, copper is found to be best for producing the most intense "beams" of neutral kaons and lambdas. (Diss. Abstr. Int., B)

48933 MEASUREMENT OF THE DIFFERENTIAL CROSS SECTION OF PION NUCLEON CHARGE EXCHANGE SCATTERING AT 502, 566, AND 618 MeV/c AND AN EXPERIMENTAL PROPOSAL TO MEASURE THE MAGNETIC MOMENT OF THE Δ(1236). Blasberg, Dennis, John. Los Angeles; Univ. of California (1972). 135p. University Microfilms Order No. 72-20,421.

Thesis.

Two independent investigations are made. A measurement of the differential cross section for the reaction $\pi^-p \rightarrow \pi^0n$ at 502, 566 and 618 MeV/c was made at the Berkeley Bevatron. A neutron time-of-flight technique is used to identify charge exchange events. The total energy of the reaction is in the region of the P_{11}(1470) resonance. There had previously been a lack of charge exchange data near the P_{11}(1470). These measurements will improve the phase shift analyses in this region and provide better parameters for the P_{11}(1470) resonance. Radiative pion nucleon scattering was examined near the Δ(1236) resonance. When the photon energy is of the order of the resonance width, the scattering amplitude undergoes a large change in phase and the Low theorem does not apply. One can then observe dynamical effects such as off-mass shell elastic amplitudes and the electromagnetic properties of the resonance. Theoretical calculations are presented which show the differential cross section, and the polarization of the out-going nucleon can be severely modified by the magnitude and sign of the resonance's magnetic moment. Similar considerations apply for other resonances, such as the Y*(1520). An experiment was designed and apparatus tested for the purpose of measuring these dynamical effects in radiative pion nucleon scattering. (Diss. Abstr. Int., B)

48934 DETERMINATION OF RESONANCE PARAMETERS FROM PARTIAL-WAVE AMPLITUDES. Coulter, Philip W. (Univ. of Alabama, University). Phys. Rev. Lett.; 29: No. 7, 450-2(14 Aug 1972).

A simple means of separating a partial-wave amplitude into a resonant term plus an inelastic background is presented. The separation is exact if only one inelastic channel is present, but it should be a good approximation in the presence of more than one inelastic channel. Inequalities are obtained relating the elastic and inelastic widths to the background inelasticity. Comments are made regarding the application of the formalism. (auth)

48935 DIFFRACTION COHERENT PARTICLE GENERATION IN INTERACTION OF 17-GeV PIONS WITH EMULSION NUCLEI. Azimov, S. A.; Gulyamov, U. G.; Gulyamov, K. G.; Prozorova, E. I.; Chernov, G. M. (Inst. of Nuclear Physics, Tashkent). Izv. Akad. Nauk Uzb. SSR, Ser. Fiz.-Mat. Nauk; No. 5, 70-5(1971). (In Russian).

Experimental data were obtained on inelastic coherent production of particles in collisions of 17.2 GeV π-mesons with nuclei of photoemulsion. The possibility of a π^--nucleus reaction yielding, variously, $\pi^-\pi^-\pi^+$, or $3\pi^-2\pi^+$, or $2\pi^-\pi^+2\pi^\circ$ is discussed, based on the cross section for each reaction. (K.S.W.)

48936 pi$^-$p ELASTIC SCATTERING NEAR 180^0 FROM 2.15 TO 6 GeV/c. Meanley, E. S.; Anthony, R. W.; Coffin, C. T.; (and others) (Univ. of Michigan, Ann Arbor). Phys. Rev., D; 6: No. 3, 740-6(1 Aug 1972).

Differential cross section measurements are presented for π^-p elastic scattering in the backward direction, with $-0.94 > \cos \theta_{c.m.} > -1.0$, for eleven beam momenta from 2.15 to 6 GeV/c. (auth)

48937 $K_S{}^0K^-$ DECAY OF A_2^- PRODUCED BY 20.3-GeV/c π^- ON HYDROGEN. Foley, K. J. (Brookhaven National Lab., Upton, N. Y.); Love, W. A.; Ozaki, S.; (and others). Phys. Rev., D; 6: No. 3, 747-56(1 Aug 1972).

The results of an analysis of data for the reaction $\pi^-p \rightarrow K_S^0 K^-p$ at 20.3-GeV/c incident π momentum are presented. It is found that the K^0K^- effective-mass spectrum shows a single peak in the A_2 region which is well fitted by a Breit–Wigner shape. The data in the A_2-peak region are inconsistent with the split-A_2 shape reported earlier. The distribution in t of the A_2 events shows a forward dip followed by an exponential falloff. The A_2 decay angular distribution is well fitted by a single resonance with quantum numbers $J^P = 2^+$. The results of an analysis of the density-matrix elements for this reaction are given. (auth)

48938 MEASUREMENT OF THE DIFFERENTIAL CROSS SECTION FOR $\pi^-p \rightarrow n\pi^0$ AT 317, 452, AND 491 MeV/c. Berardo, P. A. (Univ. of California, Los Angeles); Haddock, R. P.; Nefkens, B. M. K.; (and others). Phys. Rev., D; 6: No. 3, 756-66 (1 Aug 1972).

Seventeen differential cross sections of the pion-nucleon charge-exchange reaction were measured at total center-of-mass energies of 1245, 1337, and 1363 MeV. Most measurements are based on the neutron-photon coincidence method, using carefully calibrated neutron counters and an efficient, large-area photon detector. The results are used to test the predictions of charge independence, with which they agree. The results also confirm the Ayed–Bareyre–Sonderegger phase-degeneracy hypothesis at $\theta_{\pi 0} = 180°$. (auth)

48939 STUDY OF $\pi^-p \rightarrow \pi^+\pi^-n$, K^+K^-n AT 15 GeV/c AND A COMPARISON WITH ABSORPTIVE ONE-PION-EXCHANGE. Williams, Hugh Harrison. Stanford, Calif.; Stanford Univ. (1972). 213p. University Microfilms Order No. 72-16,817.

Thesis.

Results are reported from a wire spark chamber experiment performed at the Stanford Linear Accelerator Center to study the production of $\pi^+\pi^-n$ final states in 15 GeV/c π^-p interactions. Approximately 10,000 $\pi^+\pi^-n$ events were detected with a $\pi\pi$ mass less than 1.0 GeV and a momentum transfer to the nucleon less than 1.0 GeV and a momentum transfer to the nucleon less than 0.3 (GeV/c)^2. The density matrix elements of the dipion system were determined as a function of momentum transfer by fitting the observed $\pi\pi$ angular distribution to the theoretical angular distribution function for s- and p-waves, modified by the detection efficiency of the apparatus. The analysis was performed on events with a $\pi\pi$ mass in the interval 0.665–0.865 GeV. Many of the density matrix elements in the helicity frame are observed to exhibit structure for momentum transfers less than M_π^2. In particular, there is a pronounced dip in the value of ρ_{00}-ρ_{11} which has not been previously observed. The interference terms between the longitudinal and transverse p-wave amplitudes and between the transverse p-wave and the s-wave amplitude exhibit similar shape and change sign at momentum transfers equal to m_π^2. The longitudinal and total differential cross sections also decrease rapidly in the forward direction, while the cross section for transversely polarized rho mesons exhibits a sharp rise analogous to that observed in single-pion photoproduction. Each of the qualitative features is correctly predicted by the absorptive OPE model. In addition, a five-parameter fit of the model to the data quantitatively reproduces all of the observed structure. It is therefore concluded that the model provides a rather good explanation of this reaction at small momentum transfers. In addition to the $\pi^+\pi^-n$ events, K^+K^-n and $p\bar{p}n$ states were also detected and identified by the Čerenkov counter. The production of ϕn events which subsequently decay into K^+K^-n is observed to proceed with a cross section of 65 ± 26 μb. No sharp structure is observed in the $p\bar{p}$ mass spectrum, but this final state is produced with a relatively large cross section; the ratio of $p\bar{p}n$ to K^+K^-n final states is approximately 1:1. (TSS) (Diss. Abstr. Int., B)

Particle Interactions and Properties (Theoretical)

General

Refer also to abstracts 49169 and 49227.

48940 (COO-3130-TA-265) PROGRESS REPORT FOR A RESEARCH PROGRAM IN THEORETICAL HIGH-ENERGY PHYSICS. Feldman, David (Brown Univ., Providence, R. I. Dept. of Physics). 1 Jun 1972. Contract AT(11-1)-3130. 11p. Dep. NTIS.

Research in theoretical high energy physics is summarized and includes high energy nuclear physics, elementary particle physics, quantum field theory, and field theoretic methods for general relativity theory. A list of publications is included. (J.F.P.)

48941 (COO-3130-TA-267) DUAL-MODEL ANALYSIS OF SINGLE-PARTICLE PRODUCTION AT INTERMEDIATE ENERGIES. Kang, Kyungsik; Shen, Pu (Brown Univ., Providence, R. I. Dept. of Physics). 1972. 15p. Dep. NTIS.

A systematic numerical analysis of the single-particle distribution is presented in a dual-resonance model at energies presently accessible. The results are in reasonably good agreement with experiments. In addition, a criteria for the scaling limit in energy is suggested and the pion production rate is predicted to be much slower in the pionization limit than at intermediate energies. (auth)

48942 (IS-2915) DUAL AND DUAL-POMERON CALCULATIONS: A DOCUMENTATION. Johnson, D. E. (Ames Lab., Iowa). Jul 1972. Contract W-7405-eng-82. 38p. Dep. NTIS.

The methods used by D. E. Johnson to calculate totally dual and dual-Pomeron diagrams for three-body final state high energy reactions are described. These calculations include Monte Carlo integration of diagrams, histogram building and plotting, and comparison with data, and are written for use on either an IBM 360/65 or an EMR 6050. (auth)

48943 (JINR-E2-6157) INTERNATIONAL JINR—CERN SCHOOL ON HIGH ENERGY PHYSICS. VOLUME 2. Lectures Submitted to "Black Sea Summer School," Varna, Bulgaria, 13–27 June 1971. (Joint Inst. for Nuclear Research, Dubna (USSR)). 1972. 287p. Dep. NTIS (U. S. Sales Only).

There were six lectures included. Separate abstracts were prepared for all lectures. (J.F.P.)

For abstracts of individual lectures see: 48944, 48945, 49029, 49030, 49096, and 49215.

48944 (JINR-E2-6157, pp 6-91) ELASTIC AND QUASI-ELASTIC HADRONIC INTERACTIONS. Shirkov, D. V. (Lund Univ., Sweden).

The lectures cover phase shift analysis and Argand diagrams, resonances, the dispersion relation method and high- and low-energy applications, the general picture, and open problems. (J.F.P.)

48945 (JINR-E2-6157, pp 145-207) LECTURES ON MULTIPARTICLE PRODUCTION AT HIGH ENERGIES. Bialas, A. (Jagellonian Univ., Krakow. Inst. of Nuclear Physics, Krakow).

In these lectures the energy-independent features of the data on multiparticle production at high energies including elastic scattering and total cross sections, diffraction dissociation, and single-particle distributions observed in the many-particle production processes are discussed. The diffractive production experiment, a model of diffractive production of particles, a scaling law for the single particle distribution, and a generalized unitarity relation are covered. (J.F.P.)

48946 VVEDENIE V TEORIYU ELEMENTARNYKH CHASTITS. (Introduction to the Theory of Elementary Particles). Novozhilov, Yu. V. Moscow; Izdatel'stvo Nauka Glavnaya Redaktsiya Fiziko-Matematicheskoi Literatury (1972). 472p.

A systematic exposition of the contemporary theory of elementary particles is offered, beginning with the relativistic quantum theory, and bases for a phenomenological description. Relativistic kinematics and reflection are examined, including Lorentz and SL(2,c) groups, the quantum-mechanical Poincare group, and wave functions and equations of motion for particles having arbitrary spin. Internal symmetry- isospin and SU_3 symmetries are treated. The elements of dynamic theory are discussed: S-matrix, currents, and crossing-symmetry, scattering amplitudes, duality, and electromagnetic currents. (K.S.W.)

48947 MULTIPARTICLE PRODUCTION: FEYNMAN FLUID ANALOGY. Bander, Myron (Univ. of California, Irvine). Phys. Rev., D; 6: No. 1, 164-9(1 Jul 1972).

The analogy between high-energy events with many particles in the final state and a distribution of particles in a fluid is examined in detail. It is shown that many theoretical models lend themselves to such an interpretation. Using experimental data on prong cross sections and one-particle inclusive distributions, some properties of this analogous fluid are computed. The possibility and significance of a "phase transition" are discussed and predictions based on such considerations are made for higher energies. (auth)

48948 ϕ^3 ANALYTICITY AND FINITE-ENERGY SUM RULE FOR INCLUSIVE REACTIONS. Sanda, A. I. (National Accelerator Lab., Batavia, Ill.). Phys. Rev., D; 6: No. 1, 280-92(1 Jul 1972).

Using ϕ^3 theory as a model, the analytic structure of the six-point function is investigated. Specifically studied is the kinematical region appropriate to the single-particle inclusive reaction where the missing mass is much less than the incident energy. With some idea about the analyticity, a finite-energy sum rule is derived. This sum rule can be used to study the concept of generalized duality. The most striking feature of the sum rule is a possibility that the "triple-Regge vertex function" can be calculated by the data on the inclusive reaction with relatively low missing mass, i.e., the resonance-production region. (auth)

48949 CORRELATION LENGTHS, INCLUSIVE TRANSVERSE-MOMENTUM DISTRIBUTIONS, AND MULTIPERIPHERALISM. Mak, Se-yuen; Tan, Chung-i (Brown Univ., Providence). Phys. Rev., D; 6: No. 1, 351-66(1 Jul 1972).

Transverse-momentum distributions in the pionization region of the single- and the two-particle inclusive reactions are studied using multiperipheral models. It is found that the slope of the diffraction peak for the elastic scattering can be used to set the scale of transverse momenta. The same reasonings also lead to a "broadening" of $\langle q_\perp^2 \rangle$ for the single-particle distribution and to a positive correlation, peaking at $\cos\theta = -1$, for the two-particle distribution. The latter effect is due to the existence of a lower J-plane singularity (a branch point for a multi-Regge model), thus having a correlation length $(\alpha_\nu - \alpha_c)^{-1}$. These general results are then verified by calculations based on an explicit multi-Regge model. It is suggested that the predictions are applicable to $a + b \rightarrow \pi^+ + \pi^+ +$ anything, and $a + b \rightarrow \pi^- + \pi^- +$ anything, where the two detected final particles have exotic quantum numbers. (auth)

48950 FORM FACTORS, DIMENSIONALITIES OF OPERATORS, FIXED SINGULARITIES, AND BJORKEN LIMIT IN EXCLUSIVE PROCESSES. Bishari, Mordechai (Univ. of California, Berkeley). Phys. Rev., D; 6: No. 1, 294-300(1 Jul 1972).

A study of exclusive processes is presented. A simple one-current dual model is used as a theoretical laboratory for abstracting properties of the exclusive process which are also confirmed from general considerations. The form of the amplitude in the scaling limit is $\nu^\delta F(\omega,t)$ with δ being independent of ω and t. The parameter δ is also related to the rate of convergence of form factors as well as to fixed singularities in the angular momentum plane. Comparison with the light-cone-dominance approach is given and δ is shown to be simply related to a parameter d, which is given by the dimensions of the operators involved in the expansion of the product of the weak current with a strong source, and determines the singularity strength near the light cone. Possible determinations of d (or, alternatively δ) are outlined. An example of "evaluating" d from coupling constants and Regge intercept is presented, which strongly supports the notion of noncanonical dimensions. It is remarked that, in the model discussed, the annihilation channel scales in the same way as the electroproduction process. (auth)

48951 BILOCAL OPERATORS AND PARTONS. Jackiw, R.; Waltz, R. E. (Massachusetts Inst. of Tech., Cambridge). Phys. Rev., D; 6: No. 2, 702-15(15 Jul 1972).

The technique of light-cone commutators is used to illuminate the physical picture of deep-inelastic scattering given by the parton model. It is found that final-state interactions can be consistent with scaling, and occur in the deep-inelastic domain when vector gluons are present. It is shown how a nonvanishing longitudinal scaling function can emerge in a fermion parton model. Finally the anomalies which beset light-cone commutators in perturbation theory are studied. (auth)

48952 CURRENT-STRESS-TENSOR COMMUTATORS AND WARD IDENTITIES. Perrin, Robert (Northeastern Univ., Boston). Phys. Rev., D; 6: No. 2, 607-18(15 Jul 1972).

The model-dependent current—stress-tensor commutators are determined by requiring that the spatial components of the currents have scale dimension 3, and that the Jacobi identity of J^0-Θ^{00}-Θ^{0i} be satisfied up to terms including one derivative of a δ function. Ward-identity techniques are then used to study the J^μ-J^ν-$\Theta^{\rho\lambda}$ three-point function. Covariant proper functions are defined by adding seagull terms to the time-ordered products. These seagull terms contribute to the Ward identities for the proper functions, rather than simply canceling the Schwinger-term contributions. A single-particle-dominance approximation is then used for all spectral functions, and a solution to the Ward identities is obtained. The σ couplings, implied by the solutions, do not correspond to the usual assumptions of maximal smoothness of the J^μ-J^ν-Θ_ρ^ρ vertex. (auth)

48953 INCLUSIVE PROCESSES AT LARGE MASS. Brandt, Richard A. (New York Univ., N. Y.); Preparata Giuliano Phys. Rev., D; 6: No. 2, 619-24(15 Jul 1972).

The combined assumptions of strongly convergent operator-product expansions near the light cone (LC) and pure multi-Regge theory are used to study the inclusive process $\sigma(p) + \sigma(p') \rightarrow \gamma(q) +$ anything, where σ and γ are scalar particles, in the limit of large $s = (p + p')^2$, $\nu = p \cdot q$, $\nu' = p' \cdot q$, and $\kappa = q^2$. The leading LC singularity is used to obtain the behavior for $\kappa \to \infty$, with s/κ, ν/κ, and ν'/κ fixed. The results are not changed by including nonleading LC contributions. The result for large s/κ, ν/κ, ν'/κ with fixed ratio $\eta = \nu\nu'/s\kappa$ is made to agree with the large-κ fixed-η behavior of the Regge (pionization) limit of large s, ν, ν' and fixed η and κ. It is found that the cross section $d\sigma/d\kappa$ is a sum of two different exponentially falling terms, one being the pionization contribution and the other being the fragmentation contribution. (auth)

48954 MATHEMATICAL PROBLEMS IN THEORIES OF PARTICLES AND FIELDS. French–Swedish Symposium Held at Goteborg, June 7–11, 1971. Goteborg; Chalmers Tekniska Hogskola (1971). 98p. (CONF-710650; CTH-ITP–71-16).

The conference included seven papers. Separate abstracts were prepared for each paper. (J.F.P.)

For abstracts of individual papers see: 48955, 48956, 49058, 49107, 49151, 49152, and 49179.

48955 COVARIANT SPIN ANALYSIS OF MULTIPARTICLE AMPLITUDES. Enflo, B. O.; Laurent, B. E. pp 26–8 of Mathematical Problems in Theories of Particles and Fields. Goteborg; Chalmers Tekniska Hogskola (1971).

From Mathematical problems in theories of particles and fields conference; Goteborg, Sweden (7 Jun 1971). See CONF-710650; CTH-ITP–71-16.

A general scheme for treating the spin covariantly in arbitrary processes is proposed. The method outlined provides a tool for studying all kinds of symmetries of the M-function, including crossing symmetry and the Pauli principle. The formalism is expressed throughout in a manifestly covariant way in terms of the momenta. Amplitudes, free from kinematical singularities, can easily be constructed from the invariant amplitudes. (FHS) (Sweden)

48956 KINEMATIC SINGULARITIES IN MULTI-PARTICLE PROCESSES DERIVED FROM BASIC PROPERTIES OF SPINOR AMPLITUDES. Johannesson, N. pp 29–35 of Mathematical Problems in Theories of Particles and Fields. Goteborg; Chalmers Tekniska Hogskola (1971).

From Mathematical problems in theories of particles and fields conference; Goteborg, Sweden (7 Jun 1971). See CONF-710650; CTH-ITP–71-16.

Kinematic singularities for multi-particle processes are derived from basic properties of spinor amplitudes. Helicity amplitudes are chosen as an example, but the method can easily be applied to other spin bases. (FHS) (Sweden)

48957 PARTICLE PHYSICS. Conference Held at Irvine, California, December 3–4, 1971. Bander, Myron; Shaw, Gordon L.; Wong, David Y. (eds.). AIP Conference Proceedings, Number 6. Particles and Fields Subseries No. 2. New York; American Institute of Physics (1972). 190p. \$8.25. (CONF-711220).

The conference included seven papers. Separate abstracts were prepared for all papers. (J.F.P.)

For abstracts of individual papers see: 48907, 48958, 48999, 49025, 49112, 49120, and 49121.

48958 PHENOMENOLOGICAL DUALITY FOR INCLUSIVE REACTIONS. Einhorn, Martin B. (Univ. of California, Berkeley). AIP (Amer. Inst. Phys.) Conf. Proc.; No. 6, 100-7(1972).

From Conference on particle physics; Irvine, CA. (3 Dec 1971). See CONF-711220.

Phenomenological duality for two-body inclusive reactions is reviewed. The discontinuity of an amplitude as the sum of two terms F = p + R, the Harari–Freund hypothesis, inclusive cross sections, and duality diagrams and the twisted loop model for the pomeron are covered. (J.F.P.)

48959 REGGE BRANCH CUTS AND DISTRIBUTION OF HADRON MULTIPLICITY AT HIGH ENERGY. Abramovskii, V. A.; Kancheli, O. V. (Inst. of Physics, Tbilisi, USSR). JETP Lett. (USSR) (Engl. Transl.); 15: No. 9, 397-400(5 May 1972).

Translated from Zh. Eksp. Teor. Fiz., Pis'ma Red.; 15: No. 9, 559-63(5 May 1972).

The effect of multi-pomeron exchange on the structure of the particle-number distribution function at high energies is considered. (J.F.P.)

48960 NEW THEORY OF ELEMENTARY MATTER. PART IV. TWO-PARTICLE SYSTEMS: THE PARTICLE–ANTIPARTICLE PAIR AND HYDROGEN. Sachs, Mendel (State Univ. of New York, Buffalo). Int. J. Theor. Phys.; 5: No. 3, 161-97 (1972).

The general theory developed thus far (Internat. J. Theor. Phys. 5: No. 1-3 (1972)) is applied to two-particle systems. An exact bound state solution of the nonlinear field equations of this theory for a particle–antiparticle pair is demonstrated. From the Lagrangian formalism this solution is shown to predict all of the experimental facts that are conventionally interpreted in terms of "pair annihilation:" (1) the energy–momentum four-vector and each of the four components, separately are zero, compared with the energy, $2mc^2$, of the state when the particle and antiparticle are asymptotically free, and (2) the dynamical properties of this state of positronium make it appear in experimentation as two distinguishable currents, correlated with a 90° phase difference and polarized in a plane that is perpendicular to the direction of propagation of interaction with other charged matter. The latter features are conveniently interpreted as the two photons which are produced in the annihilation event but there are no photons in this theory. The spectral distribution of blackbody radiation is then derived from the properties of an ideal gas of such pairs, in their ground states of null energy–momentum, as observed in a finite cavity. The properties of the closed electron–proton system are considered and the entire hydrogen spectrum is derived—including the Lamb splitting. The correct lifetimes of the excited hydrogenic states are then derived by considering the radiating hydrogen gas to be immersed in the ideal gas of pairs, that explained blackbody radiation. (auth)

48961 HIGH ENERGY PHYSICS INDEX. VOLUME 10, No. 11, 1972. Frankfurt am Main; Zentralstelle fuer Atomkernenergie-Dokumentation (1972). 79p.

48962 HIGH ENERGY PHYSICS INDEX. VOLUME 10, NO. 13, 1972. Frankfurt am Main; Zentralstelle fuer Atomkernenergie-Dokumentation (1972). 75p.

48963 HIGH ENERGY PHYSICS INDEX. VOLUME 10, NO. 12, 1972. Frankfurt am Main; Zentralstelle fuer Atomkernenergie-Dokumentation (1972). 108p.

48964 NONRELATIVISTIC LIMIT OF A DYNAMICAL PROPER TIME. Papp, E. (Polytechnic Inst., Cluj). Nuovo Cim.; 10B: No. 2, 471-82(11 Aug 1972).

The quantum-relativistic proper time, associated in a wave-packet formalism with the Dirac and Klein–Gordon scattered particles, is evaluated. Taking the nonrelativistic limit of the obtained proper time, it is found that this limit may be interpreted as expressing an invariant interaction time shift. (auth)

48965 MANY-PARTICLE PRODUCTION. Horn, D. (CERN, Geneva. Tel-Aviv Univ., Israel). Phys. Rep.; 4: No. 1, 1-65 (1972).

Recent developments in the theoretical and experimental analysis of many-particle production are discussed. After a summary of the main characteristics of the high energy reactions, the features of the multiperipheral model are discussed as an introduction to the recent theoretical developments. The longitudinal kinematics and some of their manifestations in the behavior of cross sections are reviewed before turning to the concepts of scaling and limiting fragmentation. The implications of these approaches are compared with available experimental data. This leads to the Reggeistic picture developed in Mueller's analysis. Its results are reviewed and analyzed in the regions of limiting fragmentation and pionization. Separate sections are then devoted to the triple-Regge limit and to diffraction dissociation. Correlations are discussed pointing out open problems for future research. (auth)

48966 NONCOLLINEARITY OF VELOCITY AND MOMENTUM OF SPINNING PARTICLES. Costa de Beauregard, Olivier (Univ., Paris). Found. Phys.; 2: No. 2-3, 111-27(Apr 1972).

A theoretical and experimental search for the so-called Weyssenhof behavior of a spinning particle, due to the noncollinearity of its velocity and momentum, was undertaken. Z-independent solutions of Maxwell's equation had previously been produced with a nonzero s^z component of the Poynting vector; indeed, Imbert emphasized that the spatial exponential damping of Fresnel's evanescent wave would entail a nonzero value for the integral $\int\int s^z\, dx\, dy$. Excellent experimental verifications of this point have been obtained by Imbert. Besides having no z component of their momentum, the energy-momentum quanta inside Fresnel's evanescent wave have typical tachyon properties, the imaginary character of their y component (normal to the reflecting surface) entailing that (in units such that c = 1) their x component is larger than the energy quanta. Imbert is now planning experiments to test these interesting properties. Thus, the two main aspects of noncollinearity of velocity and momentum of spinning particles would be displayed. (auth)

48967 MAIN FACTORS CONTROLLING AN INCLUSIVE PROCESS IN THE ENERGY INTERVAL 20 TO 1500 GeV. Roinishvili, N. N. (Inst. of Physics, Tbilisi, USSR). JETP Lett. (USSR) (Engl. Transl.); 15: No. 9, 362-5(5 May 1972).

Translated from Zh. Eksp. Teor. Fiz., Pis'ma Red.; 15: No. 9, 512-16(5 May 1972).

It is shown that in the energy interval from 20 to 1500 GeV the inclusive interaction is completely described by the laws governing a phase space whose uniform filling is distorted only by the smallness of the transverse momentum. It is also shown that a convenient and sufficiently accurate approximation of these laws is the two-temperature distribution. (J.F.P.)

Electromagnetic

Refer also to abstracts 49133, 49135, 49139, 49143, 49158, 49162, 49166, 49175, and 49214.

48968 (CERN-Trans-72-1) ACTUAL STATUS OF THE PROBLEM OF THE MAGNETIC CHARGE. Usachev, Yu. D. (Akademiya Nauk SSSR, Moscow. Institut Fiziki). Translated by E. Jardon and Revised by N. Mouravieff (CERN, Geneva, Switzerland), from a Russian Report. 33p. (In French). Dep. NTIS (U. S. Sales Only).

A review of the status of the magnetic monopole is presented covering the Dirac and Schwinger theories, the quantization theorem, magnetic charge theory, and some deductions for experiment. (J.F.P.)

48969 (COO-3067(2)-11) SCALING PROPERTIES IN WEAK AND ELECTROMAGNETIC PROCESSES. Lee, T. D. (Columbia Univ., New York). 1972. Contract AT(11-1)-3067. 26p. Dep. NTIS.

The scaling properties in high energy weak and electromagnetic processes are reviewed, and their theoretical basis examined. (auth)

48970 (JINR-E2-6527) REACTION $\gamma + \gamma \to \pi + \pi$ AND PION ELECTROMAGNETIC MASS DIFFERENCE. Isaev, P. S.; Khleskov, V. I. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics). 1972. 33p. Dep. NTIS (U. S. Sales Only).

The $\gamma + \gamma \to \pi + \pi$ reaction was studied by dispersion relation method. The electromagnetic $\pi^{\pm} - \pi^0$ mass difference was calculated by means of the $\gamma + \gamma \to \pi^+ + \pi^-$ amplitude for virtual γ-quanta. (auth)

48971 (NP-19222) CORRECTIONS ON A MAGNETIC CHANNEL FOR MULTIPLE COULOMB SCATTERING. Note No. 331. Persi, P. (Rome Univ. (Italy). Istituto di Fisica. Istituto Nazionale di Fisica Nucleare, Rome (Italy)). 26 Jul 1971. 13p. (In Italian). Dep. NTIS (U. S. Sales Only).

The percentage of particles crossing a magnetic channel undergoing a deviation by multiple Coulomb scattering greater than the acceptance of the experimental apparatus can be calculated. This calculation is done by making a correction to the number of protons of the magnetic channel during the double photoproduction of pions in hydrogen. An example is given of the numerical calculation in the horizontal plane. (J.S.R.)

48972 (SLAC-PUB-1041) PHOTOPRODUCTION AND VECTOR DOMINANCE. Leith, David W. G. S. (Stanford Linear Accelerator Center, Calif.). 1970. 207p. Dep. NTIS.

Lectures are given on photoproduction processes, which are compared to the predictions of the vector dominance model. The data on the photoproduction of vector mesons on protons, deuterons, and complex nuclear targets, Compton scattering, total photoabsorption cross sections, and the existence of higher mass vector mesons are discussed. (J.F.P.)

48973 S-MATRIX PERTURBATION THEORY AND FIELD-THEORETIC SELF-ENERGY CALCULATIONS. Mehta, N. (Univ., Groningen, Netherlands). Indian J. Phys.; 45: No. 8, 350-61(Aug 1971).

The relation of earlier field theoretic self-energy calculations to the dispersion theoretic perturbation theory of Dashen and Frautschi (1964) is investigated. (auth)

48974 CLASSICAL ELECTRODYNAMICS IN CURVED SPACE-TIMES. Tacawy, Amir Yanny. Laramie, Wyo.; Univ. of Wyoming (1971). 70p. University Microfilms Order No. 72-18,342.

Thesis.

The problem of a moving charged point particle in an arbitrary Riemannian space is carefully examined. The equations of motion are derived directly from a nondivergent action integral which obviates the classical mass renormalization procedure. The technique used is simple and direct, in that there is no need to construct the world tube to calculate the particle-field energy-momentum balance. The resulting equations of motion differ demonstrably from those of DeWitt and Brehme and of Hobbs due to mathematical errors in their calculations. The Ricci tensor appears explicitly in the equations of motion. (Diss. Abstr. Int., B)

48975 PHOTOPRODUCTION OF NEUTRAL PIONS BY NUCLEONS AND NUCLEI. Govorkov, B. B.; Denisov, S. P.; Minarik, E. V. Tr. Fiz. Inst., Akad. Nauk SSSR; 54: 3-77 (1971). (In Russian).

Photoproduction of π^0-mesons by protons and complex nuclei in the low energy region was explored both theoretically and experimentally. Fundamental dynamic characteristics of the process for hydrogen were determined, and a detailed comparison of the test data with dispersion theory was made. Reasons are advanced for a divergence of experiment with theory. The predominant process was the elastic coherent formation of π^0-mesons. Structural parameters of the nuclei were measured from the experimental data. (tr-auth)

48976 UNIVERSAL LIGHT CONE COMMUTATOR. Brandt, R. A. (New York Univ., N. Y. CERN, Geneva). Phys. Lett.; 33B: No. 4, 312-16(26 Oct 1970).

An operator generalization of a previously considered universal light cone current commutator is proposed. It involves the vector $J_{\mu}^{a}(x)$ and scalar $S^{a}(x)$ elements of the U(12) algebra as well as the vector P_{μ} and scalar M^2 elements of the Poincaré enveloping algebra. The requirements imposed by the proposal on the light cone behavior of the current commutator are deduced and discussed. (auth)

48977 OCTET DOMINANCE OF BARYON MATRIX ELEMENTS AND THE VANISHING OF THE NEUTRON CHARGE RADIUS. Farrar, Glennys R. (Inst. for Advanced Study, Princeton, N. J.). Phys. Rev., D; 6: No. 1, 292-4(1 Jul 1972).

The baryon form factor g_V of the vector current is investigated. It is demonstrated that the d-type contribution to g_V is proportional to the matrix element of a decuplet operator between baryon states. Hence, if a dynamical mechanism exists which suppresses such matrix elements, the neutron charge form factor will be small even for nonzero q^2. This provides an explanation for the observed vanishing of the neutron charge radius. (auth)

48978 MEASURING $\pi - \pi$ PHASE SHIFTS IN COLLIDING-BEAM EXPERIMENTS. Carlson, Carl E. (Univ. of Chicago); Tung, Wu-ki. Phys. Rev., D; 6: No. 1, 147-60(1 Jul 1972).

The possibility of exploiting the unique features of the two-photon process $ee \to ee\pi\pi$ in colliding-beam experiments to measure the even partial-wave $\pi - \pi$ phase shifts is examined in detail. The commonly used Weizsäcker–Williams approximation is shown to be inadequate. An exact procedure of phenomenological analysis for extracting the relevant phase shifts is formulated. Dynamical (model-dependent) calculations are performed separately to study the expected effects due to the final-state pion–pion interaction. The sensitivity of the measured cross sections to various prominent features of the s-wave $\pi - \pi$ phase shifts (scattering length, existence of the scalar-meson resonance) is investigated. (auth)

48979 POSITIVE-PION PHOTOPRODUCTION IN THE BACKWARD DIRECTION. Ekstrand, K.; Browman, A.; Hand, L.; Nordberg, M. E. Jr. (Cornell Univ., Ithaca, N. Y.). Phys. Rev., D; 6: No. 1, 1-11(1 Jul 1972).

The reaction $\gamma + p \to \pi^+ + n$ was measured for incident γ-ray energiés from 0.7 to 8 GeV and recoil lab angles from 170° to 180° using the Cornell 10-GeV synchrotron. The data presented here cover the transition region between the resonance region and the high-energy region studied at SLAC. The results are compared with various phenomenological Regge-pole analyses and with similar data on π^0 photoproduction taken at DESY. (auth)

48980 MUON MAGNETIC MOMENT IN A FINITE THEORY OF WEAK AND ELECTROMAGNETIC INTERACTIONS. Bars, I.; Yoshimura, M. (Univ. of California, Berkeley). Phys. Rev., D; 6: No. 1, 374-6(1 Jul 1972).

The weak-interaction contribution to the muon anomalous magnetic moment of the order $G_W m_{\mu}^2$ is calculated in the Weinberg model for leptons. Using a ξ-limiting procedure a finite correction to $\frac{1}{2}(g-2)$ is obtained, which has the value $(1.8 - 2.2) \times 10^{-9}$. (auth)

48981 PARTON DUAL-RESONANCE MODEL FOR THE LEPTON-HADRONIC AND THE COLLIDING-BEAM INCLUSIVE REACTIONS. Yu, Loh-ping (Univ. of California, Berkeley). Phys. Rev., D; 6: No. 1, 215-28(1 Jul 1972).

A unified representation of νW_2 and W_1 for both electroproduction, $e^- + N \to e^-$ + anything, and the colliding-beam reaction $e^+ + e^- \to \overline{N}$ + anything is presented. The model is generalized to the case of detecting one more hadronic final-state particle, and obtaining formulas for all four structure functions for both the reaction $l + h_1 \to l + h_2$ + anything and the reaction $l + \bar{l} \to h_1 + h_2$ + anything. The explicit formulas further unify the generalized Bjorken scaling law with the Feynman scaling law. A discussion is then given on the fragmentation of the target hadron, the fragmentation of the heavy virtual photon, the two triple-Reggeon limits, the two pionization (nucleonization) limits, the "four-Reggeon" limit, the "fixed-angle" limits, and the generalized threshold behaviors of Bloom and Gilman. The pionization region again shows a universal cutoff of $\exp(-4p_\perp^2)$ in the transverse momentum, and predicts the average multiplicity distribution $\langle n \rangle = a + b \ln s$, where s is the square of missing masses. Formulas for all structure functions for further generalization to an arbitrary number of detected final-state particles are also given. (auth)

48982 PHENOMENOLOGY OF PHOTON PROCESSES, VECTOR DOMINANCE, AND CRUCIAL TESTS FOR PARTON MODELS. Brodsky, Stanley J.; Close, Francis E.; Gunion, J. F. (Stanford Univ., Calif.). Phys. Rev., D; 6: No. 1, 177-89(1 Jul 1972).

The phenomenological consequences of parton models for photon processes are discussed. In particular, the "breakdown" of vector-meson dominance in Compton scattering is correlated with its failure in nuclear photoabsorption by showing that the parton model gives rise to a nonshadowed pointlike contribution which occurs only in two-photon processes. Included in this contribution is a piece which corresponds in the general Compton amplitude $T_{\mu\nu}$ to a term which is independent of energy and photon masses at fixed t. It is emphasized that failure to observe a contribution with such behavior would have profound consequences for conventional parton models. It is predicted that this contribution will have only a weak t dependence and will lead to a dominantly real spin-conserving amplitude at large t values for Compton scattering. The q^2 behavior of this fixed pole is most easily detected in wide-angle bremsstrahlung experiments, though the same mechanism will also give rise to an s-wave enhancement independent of the photon masses in $ee \rightarrow ee\pi\pi$. (auth)

48983 DETERMINATION OF THE INTENSE-FIELD MASS SHIFT OF THE ELECTRON FROM VACUUM POLARIZATION ON THE MASS SHELL. Reiss, Howard R. (American Univ., Washington, D. C.). Phys. Rev., D; 6: No. 1, 385-7(1 Jul 1972).

Results for pair production by collision of a laser beam with a bremsstrahlung beam are analyzed to ascertain if the predicted mass increase of an electron in an intense electromagnetic field can be determined from such an experiment. An affirmative conclusion is reached. Measurement of the mass shift requires a comparison of the lowest-order process with higher orders, which are experimentally discernible. (auth)

48984 $K_L^0-K_S^0$ MASS DIFFERENCE. Isgur, Nathan (Univ. of Toronto). Phys. Rev., D; 6: No. 1, 393-5(1 Jul 1972).

An unwarranted assumption in the usual pole-approximation calculations of the $K_L^0-K_S^0$ mass difference is identified. When this source of error is removed, the pole approximation gives a successful calculation of ΔM. With a nonet symmetry for the pseudoscalar mesons, $\Delta M\tau_S = 0.57$ is found, in reasonable agreement with the experimental value of 0.47. (auth)

48985 SCALING IN MULTI-TRIPLET QUARK MODELS. Gronau, Michael; Zarmi, Yair (California Inst. of Tech., Pasadena). Phys. Rev., D; 6: No. 1, 396-8(1 Jul 1972).

Asymptotic bounds for the ratio F_2^{en}/F_2^{ep}, found in the three-triplet quark model, are not obeyed by the SLAC data. In the model, this observation implies the breaking of scaling behavior in the transition from present energies to extremely high ones. Such possible breaking in multi-triplet quark models is discussed. (auth)

48986 PREDICTIONS FOR PRODUCTION OF LEPTON PAIRS AT THE CERN ISR. Landshoff, P. V.; Polkinghorne, J. C. (Cambridge Univ., Eng.). Phys. Lett.; 40B: No. 4, 463-5(24 Jul 1972).

The predictions that can be made on the basis of the parton model for the production of virtual heavy photons of mass $\sqrt{q^2}$ in collisions at ISR are considered. Total cross sections and distributions for lepton pairs from the decay of the heavy photon are examined. (auth)

48987 ARE THERE OSCILLATIONS IN THE $e^+e^- \rightarrow$ HADRONS TOTAL CROSS-SECTION. Renard, F. M. (Departement de Physique Mathematique, Montpellier, France). Phys. Lett.; 40B: No. 4, 484-6(24 Jul 1972).

On the basis of the decay of the photon into a parton-antiparton pair and of a diffractive parton-antiparton cross-section in the J = 1 state, oscillations in energy are predicted for the total cross section for e^+e^- annihilation into hadrons; the half-period of these oscillations would be of about 2 GeV and this is compatible with recent Frascati results. (auth)

48988 REGGE BEHAVIOR OF ELECTROPRODUCTION STRUCTURE FUNCTIONS. Brandt, R. A. (New York Univ., N. Y.); Vinciarelli, P.; Breidenbach, M. Phys. Lett.; 40B: No. 4, 495-500 (24 Jul 1972).

The Regge behavior $F_2(\rho) \xrightarrow[\rho\rightarrow\infty]{} C_1 + C_2\rho^{-1/2}$ of the electroproduction scaling function for protons and neutrons is studied theoretically and experimentally. The values of C_1 and C_2 are obtained from Regge fits to $\nu W_2(Q^2,\nu)$ for smaller Q^2. Regge behavior is found to set in at about $\rho = 16$. The results are used to check theoretical predictions for $\int d\rho F_2(\rho)\rho^{-2}$ and for C_1 and to give an accurate estimate of the residue of the expected fixed pole in ρ-photoproduction. (auth)

48989 INELASTIC e^-p STRUCTURE FUNCTIONS IN A GLUON MODEL. Blaha, S. (Univ. of Washington, Seattle). Phys. Lett.; 40B: No. 4, 501-2(24 Jul 1972).

Comments are made on apparent disagreements in calculations of the inelastic e^-p structure functions in the neutral vector gluon model (also known as massive QED). (auth)

48990 MAGNETIC DIPOLE MOMENT OF THE ELECTRON IN THE LADDER APPROXIMATION. Zavada, John M. Jr. (New York Univ., N. Y.). Phys. Rev., D; 6: No. 2, 677-96 (15 Jul 1972).

In order to calculate the magnetic dipole moment of the electron in a nonperturbative manner, the vertex function of quantum electrodynamics is studied in the ladder approximation. The vertex function is written as the sum of form factors and coupled, linear integral equations are derived for these form factors. After converting the system of integral equations into differential equations, the form factors are expressed by means of an infinite series. By using the leading term in the series solution, an approximation for the magnetic dipole moment of the electron is obtained. This nonperturbative approximation is considered in the limit of a large coupling constant, g, and the electric dipole moment, μ_E, of a magnetic monopole with mass M is found to be $\mu_E \sim [\sqrt{2}(4\pi)^2 g^{-1/2}]g/2M$. Assuming the neutron to be a bound state of magnetic monopoles, the electric dipole moment of the neutron is estimated as being 10^{-18} e cm. (auth)

48991 LIGHT-CONE DOMINANCE IN THE PRESENCE OF SINGULARITIES ELSEWHERE IN COORDINATE SPACE. Jaffe, Robert L. (Stanford Univ., Calif.). Phys. Rev., D; 6: No. 2, 716-19(15 Jul 1972).

In order to exemplify the special role played by the light cone ($y^2 = 0$) in highly inelastic electroproduction, the contribution to electroproduction of singularities on other hyperboloids, $y^2 = a^2 > 0$, is studied. A light-cone singularity is shown to dominate by at least the power $\nu^{1/4}$ over an equivalent singularity on the hyperboloid $y^2 = a^2$ in the Bjorken limit. Moreover, the leading contribution from a singularity at $y^2 = a^2$ is shown not to scale as a power of ν multiplying a function of $x = Q^2/2M\nu$, but instead to oscillate with the (asymptotically infinite) frequency $[a^2M\nu(1-x)]^{1/2}$ in the Bjorken limit. (auth)

48992 BJORKEN SCALING AND STRUCTURE-FUNCTION RELATIONS IN PERTURBATION THEORY. Fishbane, Paul M. (Univ. of Virginia, Charlottesville); Sullivan, J. D. Phys. Rev., D; 6: No. 2, 645-54(15 Jul 1972).

In the leading-logarithm approximation to perturbation theory the complete set of structure functions are calculated for inelastic electron, neutrino, and antineutrino scattering on proton and neutron targets. This extends the previous calculations of the νW_2 function of inelastic electron-proton scattering. The Lagrangian studied is that of the neutral-vector-gluon model—equivalently, massive quantum electrodynamics. It is found that, in spite of the logarithmic breakdown of Bjorken scaling which generally occurs in renormalizable field theories, all the structure-function relations and sum rules of the parton model and formal light-cone algebra are satisfied to leading-logarithmic accuracy in the theory. (auth)

48993 TWO-COMPONENT ALTERNATIVE TO DIRAC'S EQUATION. Biedenharn, L. C. (Duke Univ., Durham, N. C.); Han, M. Y.; van Dam, H. Phys. Rev., D; 6: No. 2, 500-19(15 Jul 1972).

An alternative to Dirac's factorization of the Klein–Gordon equation is demonstrated which yields two-component, $m \neq 0$, equations. Explicit two-component solutions for the Coulomb field, $\alpha Z/r$, are given in detail; the bound energy levels are found to be precisely the same as for the Dirac equation, differences in the spectrum are discussed. The case for general electromagnetic fields is also discussed. The Poincaré invariance of this alternative equation is proved in two distinct ways: (1) by the standard method using Poincaré generators, and (2) by a group-theoretic analysis based upon Wigner's classic work. The existence of an invertible 1–1 mapping of Dirac's equation for general electromagnetic fields into and onto the alternative equation is demonstrated. That the two alternatives are not necessarily identical (for example, if chirality has a fixed significance) is discussed. (auth)

48994 ANGULAR DISTRIBUTIONS AND A SELECTION RULE IN CHARGE-POLE REACTIONS. Zwanziger, Daniel (New York Univ., N. Y.). Phys. Rev., D; 6: No. 2, 458-70(15 Jul 1972).

In the scattering of electrically and magnetically charged particles, it is found that, besides the orbital and spin angular momentum of each particle, there is a residual angular momentum in the electromagnetic field of the in or out scattering states given by $M^{\mu\nu} = \pm \Sigma_{i>j} \mu_{ij} \times \epsilon^{\mu\nu}_{\kappa\lambda} p_i^\kappa p_j^\lambda [(p_i \cdot p_j)^2 - p_i^2 p_j^2]^{-1/2}$, where $\mu_{ij} = (4\pi)^{-1} (e_i g_j - g_i e_j)$ and p_i, e_i, g_j are the 4-momentum and electric and magnetic charges of the ith particle. Because of the addition of this $M^{\mu\nu}$ to the generator of Lorentz transformations, the scattering states do not transform like free-particle states, but the modification has a simple group-theoretical description. For each pair of particles i and j, $M^{\mu\nu}$ generates a one-dimensional representation of the little group of the pair of 4-vectors p_i, p_j. This is the subgroup of the Lorentz group which leaves both 4-vectors invariant and is isomorphic to the one-parameter group of rotations about the z axis. The problem of constructing scattering amplitudes satisfying the new kinematics is solved. For two-body decay processes 1 → 2 + 3, there results the selection rule $s_1 + s_2 + s_3 \geq |\mu_{23}| = (4\pi)^{-1} |e_2 g_3 - g_2 e_3|$ relating the spins s_i of the particles to their electric and magnetic charges. Parity- and time-reversal-violating angular distributions are found. For example, in the decay 1 → 2 + 3, if particle 1 has spin one and polarization vector $\vec{\epsilon}$, and particles 2 and 3 are spinless with $\mu_{23} = 1$, the center-of-mass angular distribution is $\vec{\epsilon} \cdot \vec{\epsilon}^* - \vec{\epsilon} \cdot \hat{q}\, \vec{\epsilon}^* \cdot \hat{q} + i\, \vec{\epsilon} \times \vec{\epsilon}^* \cdot \hat{q}$, where $\hat{q}$ is the direction of particle 2. It is found that a consistent Lorentz transformation law requires μ_{ij} to take on integral or half-integral values, but the usual connection between spin and statistics further limits μ_{ij} to integral values only. (auth)

48995 DRELL—HEARN SUM RULE FROM LIGHT-CONE CURRENT COMMUTATORS. Dicus, Duane A.; Palmer, David R. (Univ. of Rochester, N. Y.). Phys. Rev., D; 6: No. 2, 720-2(15 Jul 1972).

The Drell—Hearn sum rule for the nucleon anomalous magnetic moment is derived by using the light-cone commutator for the + components of the current. The $q^2 = 0$ limits of several other sum rules are also derived from the ++ commutator. These other sum rules have been previously derived but only by using a more model-dependent commutator. (auth)

48996 ELECTRON IN THE FIELD OF A QUANTIZED ELECTROMAGNETIC WAVE AND IN THE HOMOGENEOUS MAGNETIC FIELD. Abakarov, D. I.; Oleinik, V. P. (Inst. of Semiconductors, Kiev). Teor. Mat. Fiz.; 12: No. 1, 78-87(Jul 1972). (In Russian).

The exact solution of the eigenvalue problem is obtained for the Hamiltonian of the Dirac electron interacting with the quantized field of a monochromatic electromagnetic wave and with the external homogeneous magnetic field for the case when the direction of the wave propagation coincides with that of the homogeneous magnetic field. It is shown that there is a forbidden region in the energy spectrum of a system, which vanishes in the limit of switching-off the electron-photon interaction. The boundaries of this region correspond to the cyclotron resonance phenomenon, i.e., the coincidence of the electron and photon oscillator frequencies. (auth)

48997 SPACE—TIME PHENOMENOLOGY OF PHOTON ABSORPTION AND INELASTIC ELECTRON SCATTERING. Suri, Ashok (Stanford Univ., Calif. Univ. of California, Santa Cruz); Yennie, Donald R. Ann. Phys. (N. Y.); 72: No. 1, 243-92(Jul 1972).

The space—time phenomenology of real and virtual photon absorption by nucleons is discussed, with the aim of developing intuition about these processes. It is argued that they may be understood in terms of two principal types of interactions, a short-range one, referred to as a bare-photon interaction, and a long-range one, which represents the hadronic constituent of the photon. This hadronic constituent is not restricted to the surface of the light cone. A tentative interpretation of the data in terms of these two types of interaction is given. The principal feature of the data analysis is that the slow approach to scaling at small x is due to the long-range terms. It is found that, in general, scaling should be expected to set in when $\nu R_p \gg 1$ and $Q^2/m^2 \gg 1$; here R_p is a size, characteristic of the structure of the target, and m is a mass, characteristic of the hadronic constituents of the incident photon. Scaling and a power-law fall off at large longitudinal distances for the absorptive part of the forward Compton amplitude are assumed. A Regge-like behavior for the total cross section and for the scaling-structure functions at small x is found. The intercept of the Regge trajectory turns out to be intimately related to the power of this large-distance fall off. (10 figures) (auth)

48998 s-CHANNEL TRANSFORMATION MATRICES FOR HELICITY AND INVARIANT AMPLITUDES FOR $\gamma + N \rightarrow 0^- + B$. Parsons, Ronald G. (Univ. of Texas, Austin). Ann. Phys. (N. Y.); 72: No. 1, 171-6(Jul 1972).

The algebraic transformation matrices, valid for all s and t, connecting the s-channel helicity amplitudes to a corresponding set of gauge-invariant covariant amplitudes are calculated for the photoproduction processes $\gamma + N \rightarrow 0^- + B(J^P = 1/2^+, 1/2^-, 3/2^+, 3/2^-)$. (2 figures) (auth)

48999 DEEP-INELASTIC ELECTROPRODUCTION. Bjorken, James D. (Stanford Univ., Calif.). AIP (Amer. Inst. Phys.) Conf. Proc.; No. 6, 151-63(1972).

From Conference on particle physics; Irvine, CA. (3 Dec 1971). See CONF-711220.

The treatment covers the kindergarten parton model, precocious scaling, the relation among vector dominance, partons, and $e^+ + e^-$ annihilation for hadron final states in electroproduction, and deep inelastic phenomena in perturbation theory for structure functions for electroproduction. (J.F.P.)

49000 PROPERTIES OF THE SYNCHROTRON RADIATION OF ELECTRONS MOVING IN A WEAKLY FOCUSING MAGNETIC FIELD. Zhukovskii, V. Ch.; Shishanin, O. E. Opt. Spectrosc. (USSR) (Engl. Transl.); 31: No. 6, 465-7(Dec 1971).

Translated from Opt. Spektrosk.; 31: No. 6, 857-61(Dec 1971).

The polarization and spectral-angular distribution of the synchrotron radiation of electrons moving in an axially symmetrical weakly focusing magnetic field are discussed. It is shown that the influence of axial betatron oscillations on the distribution of the radiation is significant even in the region of linearity of the oscillations. In particular, in contrast to the case of a homogeneous magnetic field, the radiation propagating in the plane of the equilibrium orbit ceases to be completely linearly polarized. The deviation from complete polarization is determined by the magnitude of the amplitude of axial oscillations. (auth)

49001 PHOTOPRODUCTION OF K-MESONS IN REGGE POLE MODEL WITH CUTS. Arakelyan, G. G.; Amatuni, A. Ts.; Garyaka, A. P.; Eremyan, Sh. S.; Zverev, A. M. Izv. Akad. Nauk Arm. SSR, Ser. Fiz.; 6: No. 5, 343-50(1971). (In Russian).

The photoproduction of charged and neutral K-mesons in reactions $\gamma p \rightarrow K^+\Lambda$, $K^+\Sigma^0$, $K^0\Sigma^+$ is considered, and curves for differential cross sections and asymmetry coefficients are obtained. For the production of charged kaons the evasive K and K* trajectories and the conspiring phenomenological K*P-cut are taken into account. The parameters of the model were obtained by fitting the data on the differential cross section for $\gamma p \rightarrow K^+\Lambda$. Using these results and SU(3) symmetry for the vertices the parameters for $I = 1/2$ amplitude of the reaction $\gamma p \rightarrow K^+\Sigma^0$ are calculated. The parameter β (ratio of vector meson—baryon f- and d-couplings) is taken the same for the spin-flip and nonspin-flip amplitudes and left free. An attempt to take into consideration the exotic-channel $I = (3/2)$ amplitude as the ρK^*, A_2K^*, or πK^* cuts is made. The parameters of these cuts and β are obtained by fitting the curves to the differential cross section for $\gamma p \rightarrow K^+\Sigma^0$. Then the ratio $R = D_2/H_2$ for K^+ photoproduction is calculated in the qualitative agreement with the experimental data. The differential cross sections and asymmetry parameter for the reaction $\gamma p \rightarrow K^0\Sigma^+$ are predicted, using the parameters for $\gamma p \rightarrow K^+\Sigma^0$ (without exotics and K-trajectory). The obtained cross sections coincide with the experimental upper limits reported by the Manchester and Yerevan group by the order of magnitude. It seems that the choice between different models of K-meson photoproduction will be possible after the experimental measurements of asymmetry coefficients for different values of E_γ and t. (auth)

49002 DEEP-INELASTIC PROCESS $e^- + \gamma \rightarrow e^- + n\pi^+n\pi^-$. Buchl, R. A.; Nigam, B. P. (Arizona State Univ., Tempe). Phys. Rev., D; 6: No. 3, 825-7(1 Aug 1972).

The deep-inelastic process $e^- + \gamma \rightarrow e^- + n\pi^+n\pi^-$ is considered. The differential cross section for this process is calculated using the matrix element for $\gamma + \gamma \rightarrow n\pi^+n\pi^-$ which has been derived by Terazawa in the soft-pion limit. Expressions are given for the photon structure functions, $W_1^\gamma(q^2,\nu)$ and $W_2^\gamma(q^2,\nu)$, due to the contribution of the $n\pi^+n\pi^-$ hadronic system. The photon structure functions derived are seen to obey the Bjorken limiting assumption. (auth)

49003 CORRECTIONS TO A THEOREM ON THE K_{l3} DECAY FORM FACTORS. Dashen, R. (Inst. for Advanced Study, Princeton, N. J.); Li, Ling-fong; Pagels, Heinz; Weinstein, M. Phys. Rev., D; 6: No. 3, 834-9(1 Aug 1972).

It was pointed out in a recent series of papers that for theories possessing an approximate Goldstone symmetry some physical amplitudes are necessarily nonanalytic functions of the symmetry-breaking parameter, ϵ. In particular, this fact implies some corrections to a theorem on the K_{l3} form factors, which was derived under the assumption of an approximate SU(3) × SU(3) symmetry of the Goldstone type. In this paper it is shown how these effects arise, and it is proved that $(d/dt)\ [\langle\pi^0|\partial_\mu V^\mu_{\bar{K}}(0)|K^+\rangle(t)]|_{t=m_\pi^2+m_K^2}$ is of the form $(\epsilon \ln\epsilon)A + \epsilon B + O(\epsilon^2, \epsilon^2 \ln\epsilon)$. Furthermore, it is proved that $A\epsilon \ln\epsilon = \frac{1}{2}\ (f_\pi/f_K - f_K/f_\pi)$ independently of any assumption about the structure of the symmetry-breaking term in the Hamiltonian. However the term ϵB is model-dependent. In the popular $(\bar{3},3) + (3,\bar{3})$ model this term is small as compared to the term $A\epsilon \ln\epsilon$. Also it is noted that the theorem is given at the unphysical point $t = m_\pi^2 + m_K^2$ rather than at $t = 0$ as was previously stated. (auth)

49004 SCALE INVARIANCE, FIXED POLES, AND CUTS IN COMPTON AND DEEP-INELASTIC SCATTERING. Moffat, J. W.; Snell, V. G. (Univ. of Toronto). Phys. Rev., D; 6: No. 3, 859-68(1 Aug 1972).

Finite-energy sum rules in Compton and deep-inelastic scattering are analyzed at $q^2 = 0$ and $-q^2 = \infty$ on the basis of a Regge-pole model including cuts. It is found that the sum rules can be satisfied without the use of real fixed poles. Good fits are obtained to the data for the deep-inelastic structure functions in the Regge region, and to the data for the high-energy total and differential cross sections. (auth)

49005 INTERDEPENDENCE OF REACTIONS IN MULTI-CHANNEL PROCESSES. Goradia, Y. (Univ. of Oregon, Eugene). Phys. Rev., D; 6: No. 3, 869-74(1 Aug 1972).

The generalized Watson theorem is considered for the photoproduction of two pions. Using the various available phase-shift solutions for pion-nucleon scattering, the theorem is applied to obtain lower bounds on absolute squares of partial-wave amplitudes for $\gamma N \rightarrow N\pi\pi$. From these, the lower bounds on cross sections for this process are calculated and compared with the available experimental data. (auth)

49006 COINCIDENCE ELECTROPRODUCTION AND SCALING IN THE REGGE REGION. Cheng, T. P. (Rockefeller Univ., New York); Zee, A. Phys. Rev., D; 6: No. 3, 885-93(1 Aug 1972).

The coincidence electroproduction process $l + p \rightarrow l' + p' +$ anything is considered. With the momentum transfer between p and p′ held fixed, a single trajectory in the $p\bar{p}'$ channel dominates as the laboratory energy of the virtual photon becomes large. (It is known that the onset of single-trajectory dominance may be ascertained by observing the azimuthal angular distribution of the detected hadron.) In the region of large virtual photon mass and missing mass (with their ratio fixed) the process may be picturesquely described as "deep-inelastic scattering of a lepton on a Reggeon target." The assumed Regge behavior is implemented in the language of van Hove. The scaling behavior of the various structure functions is then determined by the "canonical" light-cone commutator (taken between spin-J states), if certain smoothness assumptions are granted. Relations of the Callan–Gross type are also derived. The experimental features corresponding to the results are relatively easy to observe. The kinematics of coincidence electroproduction (with a polarized beam) is discussed in some detail. (auth)

49007 COHERENT PRODUCTION, LOW-ENERGY THEOREMS, AND ANOMALOUS WARD IDENTITIES. Zee, A. (Inst. for Advanced Study, Princeton, N. J.). Phys. Rev., D; 6: No. 3, 900-8 (1 Aug 1972).

The significance of two low-energy theorems relating $\pi \rightarrow 2\gamma$, $\gamma \rightarrow 3\pi$, and $2\gamma \rightarrow 3\pi$ is stated. The processes $\pi^\pm + (Z,A) \rightarrow (Z,A) + \pi^\pm + \pi^0$, $e^+e^- \rightarrow e^+e^-3\pi$, and $e^+e^- \rightarrow 3\pi$ are discussed as experiments providing a check on these theorems. Some rate estimates are given. (auth)

49008 t^{-2} LAW FOR ELECTROMAGNETIC FORM FACTORS. Yodzis, P. (Dublin Inst. for Advanced Studies). Phys. Rev., D; 6: No. 3, 929-31(1 Aug 1972).

It is shown that, within the context of frame-dependent cutoff quantum field theory, the slowest possible asymptotic decrease, for −t large, of the effective Sachs electromagnetic form factors is $O(t^{-2})$, where t is the invariant momentum transfer squared. The argument is model-independent and exact; it requires but a single analyticity assumption. (auth)

Weak

Refer also to abstract 49112.

49009 (JINR-E2-6544) DOES GEIGER–NUTTAL RULE EXIST FOR HYPERON DECAYS? Isaev, P. S. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics). 1972. 7p. Dep. NTIS (U. S. Sales Only).

A possibility of existence of the decay law for hyperons, which is analogous to Geiger–Nuttal rule for decays of radioactive families, is indicated. (auth)

49010 (ORO-3992-98) ON THE POINCARE NON-INVARIANCE OF A RECENT ALTERNATIVE TO THE DIRAC EQUATION. Acharya, Raghunath; Madan, Rabinder N. (Texas Univ., Austin. Center for Particle Theory). Jun 1972. Contract AT(40-1)-3992. 11p. Dep. NTIS.

The two-component factorization of the Klein–Gordon operator, proposed by Biedenharn, Han and van Dam, as an alternate to the Dirac equation for spin one-half massive leptons is investigated for its Poincaré invariance. It is found that the BHvD equation is not Poincaré invariant—and thus must be rejected. The approach is to search for the existence of ten independent infinitesimal generators H, $\underset{\sim}{P}$, $\underset{\sim}{J}$ and $\underset{\sim}{K}$ that satisfy the Lie bracket relations, characteristic of the Poincaré group. It is found that the algebra does not close except for mass zero leptons, the case of the Weyl equation. (auth)

49011 NONLEPTONIC DECAYS OF HYPERONS. Nagai, Yoshikazo Ernesto. East Lansing, Mich.; Michigan State Univ. (1971). 111p. University Microfilms Order No. 72-16,481.

Thesis.

A new analysis of the problem of calculating s- and p-wave amplitudes for nonleptonic decays of hyperons by applying dispersion relation techniques to the scattering of a spurion from a hyperon is presented. In a particular combination of amplitudes, the scattering process formally reduces to the weak decay process in the limit of vanishing four-momentum of the spurion. In this approach the Regge behavior of the scattering amplitude at high energies requires one subtraction in the dispersion relation, the subtraction point being chosen such that the calculable soft-pion amplitude gives the subtraction constant. Then the low-mass baryon pole contribution is separated from the dispersion integral with the remaining part of the integral coming from higher mass resonances. The method of evaluating this latter resonance contribution consists in assuming Regge behavior for the scattering amplitude at high energies and extrapolating this form of amplitude to the lower energy region. In this way the result of the higher-mass integration is just the real part of the Regge amplitude from the t-channel exchanges. This approach has its justification in the concept of local duality which states that the Regge amplitude, when extrapolated to lower energies, represents the true amplitude in an average sense. The addition of the resonance contribution to the soft-pion-plus-pole amplitude increases the number of adjustable parameters to four. The numerical values of these parameters are then found by a χ^2-fit to the experimental data. As a further test of the analysis predictions are made for the amplitudes of the two-body radiative weak decays of hyperons. These decays are closely related to the nonradiative ones via low-energy theorems. The main results can be summarized as follows: (a) the fit to the experimental pionic decay values is a considerable improvement over that of previous work. (b) The usual neglect of the higher-mass baryon resonances is found to be unwarranted for the s-wave. However, it is found to be fairly good for the p-wave. (c) A relatively large violation of unitary symmetry is present. (d) Octet dominance breaking is needed to explain the observed value $A(\Sigma_+^+)' \simeq 0$. (e) The available experimental information on radiative weak decays is in excellent agreement with the calculation. (Diss. Abstr. Int., B)

49012 UNOBSERVABLE W BOSON. de Closets, Francois. Sci. Avenir; No. 303, 376-85(May 1972). (In French).

The W boson, whose existence has been theoretically predicted, has never been experimentally observed. Its discovery would explain the weak interaction mechanism. (France)

49013 POSSIBLE ANOMALOUS INTERACTION IN MUON–PROTON SCATTERING AT LOW ENERGIES. Fearing, Harold W. (Los Alamos Scientific Lab., N. Mex.). Phys. Rev., D; 6: No. 1, 203-15(1 Jul 1972).

The possibility of an anomalous effect in muon–proton scattering due to the exchange of a scalar meson is investigated. This model for an anomalous effect differs from most others in that the effect cannot be described simply as a muon form factor depending on momentum transfer, but is strongly energy-dependent. The effect is largest at muon energies of a few hundred MeV and vanishingly small at the high energies of present experiments. It would thus be an appropriate experiment for the high-intensity, low-energy muon beams possible at meson facilities such as the Los Alamos Meson Physics Facility (LAMPF). Limits on such an interaction obtained from muon g-2 and muonic x-ray measurements are also investigated. For a sizable range of scalar couplings and masses a 5% effect in scattering appears to be easily possible without conflicting with other information. (auth)

49014 CPT-VIOLATING MODEL OF WEAK INTERACTIONS. Hsu, J. P. (Rutgers–The State Univ., New Brunswick, N. J. McGill Univ., Montreal); Hongoh, M. Phys. Rev., D; 6: No. 1, 256-61(1 Jul 1972).

A model of weak interactions is studied in which the divergences are no worse than those of the renormalizable theory and the CPT invariance is maximally violated. The model is consistent with all existing data, and some data favor these predictions over those of conventional theories. In particular, the model predicts that the lifetime of Λ^0 decaying in flight at 100 GeV will be shorter than that measured at rest by ~16%, a prediction which can be tested at the National Accelerator Laboratory. (auth)

49015 LIGHT-CONE APPROACH TO STRUCTURE-FUNCTION INEQUALITIES. Callan, C. G. (Inst. for Advanced Study, Princeton, N. J.); Gronau, M.; Pais, A.; Paschos, E.; Treiman, S. B. Phys. Rev., D; 6: No. 1, 387-90(1 Jul 1972).

Scaling-limit inequalities on the structure functions for inelastic lepton–nucleon scattering are considered in the light-cone model of Fritzsch and Gell-Mann. The connection with Nachtmann's parton-model approach is clarified. (auth)

49016 MODEL OF THE DECAY $K_2 \rightarrow \pi^0\gamma\gamma$ AND A UNITARITY CONSTRAINT ON THE DECAY RATE. Sehgal, L. M. (Physikalisches Institut, Aachen). Phys. Rev., D; 6: No. 1, 367-73(1 Jul 1972).

A model is presented for the decay $K_2 \rightarrow \pi^0\gamma\gamma$, in which the amplitude is determined in terms of the amplitude for $K_2 \rightarrow \pi^+\pi^-\pi^0$. The decay rate is found to be 13 $\sec^{-1}$. Using unitarity, a model-independent lower bound is obtained on the spectrum and decay rate of this reaction in the kinematical region $s > M^2 - 7\mu^2$, where s is the invariant mass squared of the photon pair and M and μ are the kaon and pion masses. (auth)

49017 LIFETIME OF THE MUON STATE OF THE ELECTRON–MUON MASS DOUBLET. Sachs, M. (State Univ. of New York, Buffalo). Nuovo Cim.; 10B: No. 1, 339-47(11 Jul 1972).

The electron and muon masses were previously derived by combining the general relativistic derivation of the inertial masses of spinor particles from the geometrical field and the model of the "physical vacuum" (from a self-consistent field theory of electrodynamics) in terms of an ideal gas of electron-positron pairs in a particular state that was derived from the theory. It was predicted earlier that in this field theory spinor particles occur in mass doublets. In the electron-muon case, the observation of the "heavy electron" (muon) is a consequence of quadrupolar excitation of the physical vacuum of pairs—correspondingly altering the geometrical field in the vicinity of the observed electron, thereby making it more inertial. The lifetime of the heavy electron in this physical vacuum is determined, de-excitation occurring by the transferral of electromagnetic energy from this heavy electron to the pairs of the physical vacuum by means of a quadrupolar transition. To facilitate the calculation with time-dependent perturbation theory, use is made of Fermi's multiple-meson production theory, and the improvisation of his theory for break-up reactions. In this way, the ensuing quantitative analysis yields a lifetime for the heavy electron that is of the order of $2.09(10)^{-6}$ s, which is within 5% of the observed muon decay rate. It is then shown how the present theory, in which electromagnetic variables are in terms of 2-component spinor fields, explains the reaction $\mu \rightarrow e + \nu + \bar{\nu}$ in terms of a process that is purely electromagnetic and does not entail neutrinos. (auth)

49018 NEUTRAL CURRENT (V–A) SCHEME AND ITS PREDICTION OF THE HELICITY PROPERTIES OF LEPTONS. Romanov, Yu. I. Izv. Akad. Nauk SSSR, Ser. Fiz.; 35: No. 11, 2386-9(Nov 1971). (In Russian).

The aggregate of experimental data (β-decay of nonoriented nuclei and a neutron, μ e-decay) has lead to the conclusion that electrons in decay processes arise with left helicity in agreement with predictions of the "contaminated" (V-A)-current scheme. Weak processes involving leptons and the phenomenon of right-polarized electrons in elastic lepton–lepton scattering are examined. (K.S.W.)

49019 INEQUIVALENCE OF THE KLEIN–GORDON AND KEMMER FORMULATIONS OF K_{13} DECAY. Fischbach, Ephraim (Purdue Univ., Lafayette, Ind.); Nieto, Michael Martin; Scott, C. K.; Nagel, Bengt; Snellman, Hakan. Phys. Rev., D; 6: No. 2, 726-33 (15 Jul 1972).

The criticism that was raised against the Kemmer K_{13} theory is answered by exhibiting in explicit calculational detail the inequivalence of the Kemmer and Klein–Gordon formulations of K_{13} decay, taking care to clearly define "inequivalence." It is shown that the published results are correct as stated, including the prediction of a zero in the scalar form factor. In answer to Fischbach, Nieto, and Scott, the argument of Nagal and Snellman for the equivalence of the Klein–Gordon and Kemmer formulations of K_{13} decay is amplified. (auth)

49020 THEORY OF HIGHER-ORDER WEAK INTERACTIONS AND CP-INVARIANCE VIOLATION. I. LEPTONIC PROCESSES. Lane, Kenneth; Chodos, Alan (Univ. of Pennsylvania, Philadelphia). Phys. Rev., D; 6: No. 2, 581-96(15 Jul 1972).

In order to cure the divergence difficulties of higher-order weak interactions, a theory is proposed in which the usual current × current Lagrangian is modified by inserting the nonpolynomial factor $\exp[f\ \varphi^\dagger\varphi(x)]$, where φ is a charged scalar field. It is shown that, as a result, the usual first-order weak amplitudes are unchanged, while second-order leptonic scattering amplitudes are finite. Explicit formulas are given for lepton-lepton scattering and the logarithmically divergent lepton self-mass. A discussion of Nth order is presented, in which it is shown that the naive degree of divergence is independent of order, and the superpropagator to all orders is derived. The groundwork is laid for the discussion in a following paper of hadronic processes and the appearance of CP violation as a higher-order weak effect. (auth)

49021 THEORY OF HIGHER-ORDER WEAK INTERACTIONS AND CP-INVARIANCE VIOLATION. II. THE NEUTRAL K SYSTEM. Chodos, Alan; Lane, Kenneth (Univ. of Pennsylvania, Philadelphia). Phys. Rev., D; 6: No. 2, 596-606(15 Jul 1972).

Continuing our exposition of a nonpolynomial theory of higher-order weak interactions, the neutral K system is examined, with particular emphasis on the CP-invariance-violating amplitudes. These first appear in second order in the weak interactions. The free-quark model is used to estimate the short-distance singularity of products of hadronic currents, and it is found that with appropriate choices of the minor coupling constants the theory is consistent with the known experimental results. In particular, $|\epsilon| \approx 10^{-3}$ is found and an argument leading to $\eta_{+-} \approx \eta_{00}$ is given. The neutron dipole moment is a third-order weak effect in the theory and is estimated to be about 10^{-27} e cm. The production cross section for the superpropagating particles is calculated and is found to be too small for the particles to have yet been observed. (auth)

49022 PROBLEM OF ANOMALOUS ORIGIN OF MASSES. II. Vasil'ev, A. N. (Leningrad State Univ.). Teor. Mat. Fiz.; 12: No. 1, 18-28(Jul 1972). (In Russian).

A continuation of the author's work (TMQ, 11, 137(1972)) is given, in which it is shown that the unified weak and electromagnetic interaction of leptons with intermediate bosons is stable with the respect to spontaneous production of the photon mass (in the sense that the mass production is energetically nonprofitable). The stability of the initially massless lepton fields is considered, and it is shown that the neutrino is stable while the charged leptons are unstable with the respect to the spontaneous mass production. The problem of the origin of mass difference of the electron and the μ-meson is also discussed. (auth)

49023 NEUTRINOS IN RAINICH GEOMETRY. Inomata, A. (State Univ. of New York, Albany). pp 199-204 of Relativity and Gravitation. /Kuper, Charles G. (ed.). New York; Gordon and Breach, Science Publishers, Inc. (1971).

From Seminar on relativity and gravitation; Haifa, Israel (15 Jul 1969). See CONF-690713.

It is pointed out that the Rainich–Misner–Wheeler scheme of the nonnull geometry can also accommodate a class of four-component neutrinos. (J.F.P.)

49024 TOPICS IN WEAK INTERACTIONS. Mainland, Gordon Bruce. Austin, Tex.; Univ. of Texas (1971). 45p. University Microfilms Order No. 72-19,627.

Thesis.

Three topics in weak interactions are considered: An alternative to the Cabibbo theory which accounts for the suppression of strangeness changing semileptonic weak decays is proposed, a phenomenological means for accounting for the vector contribution to the decay $\Sigma^- \rightarrow \Lambda + e^- + \bar{\nu}_e$ within the framework of SU(3) is suggested, and a method for predicting the mass of the conjectured intermediate vector boson is explored. Meson and baryon semileptonic decay rates are predicted by postulating that the weak-interaction currents are, in analogy to the conserved-vector-current hypothesis, equal to commutators involving the generators of SL(3,C) {SU(3) × SU(3)} and the isospin component of the electromagnetic current. Three meson semileptonic decay rates are calculated in terms of no new constants, and six baryon decay rates and six values of the quantity g_A/g_V are calculated in terms of two SL(3,C) reduced matrix elements. The predicted decay rates and values of g_A/g_V are in good agreement with experimental values. The vector contribution to the decay $\Sigma^- \rightarrow \Lambda + e^-\bar{\nu}_e$ is phenomenologically accounted for within the framework of SU(3) and the conserved vector current hypothesis by using the most general SU(3) octet matrix elements. Finally, the self-mass of a lepton resulting from linearized gravitational interactions, electromagnetic interactions, and weak interactions mediated by an intermediate vector boson is considered. If the quadratic weak and gravitational self-mass divergences, and the logarithmic weak, electromagnetic, and gravitational self-mass divergences are respectively assumed to cancel, the weak coupling constant g and the mass of the intermediate vector boson M_B can be predicted. (Diss. Abstr. Int., B)

49025 TOPICS IN WEAK INTERACTION PHYSICS. Treiman, S. B. (National Accelerator Lab., Batavia, Ill.). AIP (Amer. Inst. Phys.) Conf. Proc.; No. 6, 108-26(1972).

From Conference on particle physics; Irvine, CA. (3 Dec 1971). See CONF-711220.

A review is given of developments in field theory for weak interactions. The topics treated include the current–current model, the Weinberg model, $K_2^0 \rightarrow \mu^+ + \mu^-$ decay, deep inelastic lepton–hadron scattering, and some recent results on inclusive electron-pair annihilation. (J.F.P.)

49026 THRESHOLD RELATIONS FOR INELASTIC SCATTERING OF POLARIZED LEPTONS FROM POLARIZED NUCLEONS. Cleymans, Jean (Stanford Univ., Calif.). Phys. Rev., D; 6: No. 3, 814-16(1 Aug 1972).

Threshold relations, following from scaling and duality, are obtained for inelastic scattering of polarized leptons from polarized nucleons. (auth)

49027 LIGHT-CONE RELATIONS FOR THE STRANGENESS-CHANGING STRUCTURE FUNCTIONS. Lipkin, Harry J. (National Accelerator Lab., Batavia, Ill. Argonne National Lab., Ill. Weizmann Inst. of Science, Rehovoth, Israel); Paschos, E. A. Phys. Rev., D; 6: No. 3, 817-19(1 Aug 1972).

Light-cone relations are obtained in the scaling limit among the $\Delta S = 0$ and $\Delta S = 1$ structure functions. The main conclusions are: (i) There are kinematic regions where the $\Delta S = 1$ transitions are 7% of the $\Delta S = 0$ transitions; (ii) there are differences of the inclusive cross sections which isolate the $\Delta S = 1$ transitions; and (iii) application of the results to isoscalar nuclei eliminates the ambiguities arising in the extraction of the neutron data. (auth)

Strong (General)

Refer also to abstracts 49121, 49234, and 49235.

49028 (COO-3071-2) HADRONIC EIKONAL MODEL. Chang, L. N.; Segre, G. (Pennsylvania Univ., Philadelphia. Dept. of Physics). 24 May 1972. 50p. Dep. NTIS.

A model for hadron hadron scattering proceeding via the exchange of mesonic systems with isospin is constructed. The result can be cast in eikonal form with an effective Regge pole potential. Extensions of the model are discussed and comparisons with other models are made. (auth)

49029 (JINR-E2-6157, pp 208-32) DUALITY AND THE OSCILLATOR MODELS OF HADRONS. Montvay, I. (Eotvos Lorand Univ., Budapest).

A lecture is given on quark oscillator models and oscillator models leading to dual amplitudes. The details of the calculations are not generally considered; only the main features of the general field theoretic formalism of the oscillator models are described. (J.F.P.)

49030 (JINR-E2-6157, pp 233-87) VENEZIANO MODEL AND PHENOMENOLOGY OF HADRON REACTIONS. Pokorski, Stefan (Warsaw Univ.).

A review lecture is given on the Veneziano model as a basis for a phenomenological description of particle reactions. The predictions of this model which are expected to be almost independent of the infinitely narrow resonance limit are emphasized. Predictions of the dual narrow resonance model which can be trusted, the four point function and phenomenology, B_5 phenomenology, and the dual model for inclusive reactions are treated. (J.F.P.)

49031 (JINR-P2-6500) ANNIHILATION PROCESSES IN THE ULTRAHIGH ENERGY REGION. SUM RULES FOR CROSS SECTIONS. Mal'tsev, V. M.; Dushutin, N. K. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics). 1972. 12p. (In Russian). Dep. NTIS (U. S. Sales Only).

Annihilation of hadrons at very high energies is considered to be the Markov process. The probability of the n-particle production depends on the elementary processes in the Markov chain. Inclusive processes with the production of an arbitrary number of neutral pions are considered. Partial cross sections for a definite number of pions are connected by the sum rules; the agreement with the experiment is satisfactory. (auth)

49032 (JINR-P2-6502) CORRELATION EFFECTS IN THE JET APPROACH MODELS. Mal'tsev, V. M.; Dushutin, N. K. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics). 1972. 14p. (In Russian). Dep. NTIS (U. S. Sales Only).

The correlations in the models of jet approach are considered. The correlations in simple models are studied as well as their agreement with experiment. The restrictions on the correlation function behavior are obtained which follow from the general principles of the field theory. The properties of the scale invariance of the models are shown. (auth)

49033 (NYO-3829-92) TWIST RELATION, THIRD FACTORIZATION AND THE GENERAL VERTEX IN A DUAL MULTIPARTICLE THEORY WITH NONLINEAR TRAJECTORIES. Baker, M.; Yu, S. (Washington Univ., Seattle); Coon, D. D. (Pittsburgh Univ., Pa.). Feb 1972. Contract AT(45-1)-1388. 36p. Dep. NTIS.

The following properties of the dual multiparticle theory with nonlinear trajectories are presented: the twist relation, the unsymmetric general vertex obtained directly from third factorization, and the symmetric general vertex. (auth)

49034 (RPP/T-17) MANY-BODY PROBLEM IN HADRON REACTIONS. Chan, Hong-mo (Rutherford High Energy Lab., Chilton (England)). 1972. 48p. Dep. NTIS (U. S. Sales Only).

The review of the many-body problem in hadron reactions covers the approach to the scaling limit, factorization, and the production mechanism. (J.F.P.)

49035 SINGULAR POTENTIALS AND SOME ASPECTS OF STRONG INTERACTION PHYSICS. Misra, Ramesh Chandra. Fredericton, New Brunswick; Univ. of New Brunswick (1971). National Library of Canada, Ottawa.

Thesis.

Singular potentials of the form r^{-n}, $n > 3$, were studied with a view to understanding some features of strong interactions. For an r^{-4} potential, the Schroedinger equation can be put in the form of a modified Mathieu equation. Singular potentials are used to examine rising Regge trajectories in energy independent and energy dependent schemes. The trajectories seem to be rising nonlinearly. The conditions for rising Regge trajectories are given. An N/D decomposition of the partial wave scattering amplitude is studied for singular potentials and also for singular Yukawa potentials. In the former case, an N/D solution could exist utmost with a finite cut $C < k \leq K$, and for the latter case, a standard N/D solution is possible where the functions N and D have usual properties. Duality of strong interactions is discussed; in particular, singular potentials are shown to exhibit a complete mathematical duality for a limited range of the invariant variable in the crossed channel. (Diss. Abstr. Int., B)

49036 SOFT-PION RESULTS FOR INCLUSIVE REACTIONS. Paschos, E. A. (National Accelerator Lab., Batavia, Ill.). Phys. Rev., D; 6: No. 1, 379-82(1 Jul 1972).

Two of the main difficulties arising in the application of soft-pion methods to inclusive reactions are discussed. It is shown, by explicit calculation, that for specific reactions the entire pole contribution can be calculated in terms of physically observable quantities. Available data on hadronic reactions suggest that the contribution of the pole terms is as important as the contribution of the equal-time commutators. The other difficulty concerns the ranges of extrapolation in some variables which increase linearly with the center-of-mass energy. (auth)

49037 CAN POLARIZABILITIES OF NUCLEI AND ELEMENTARY PARTICLES BE DETERMINED FROM EXOTIC ATOMS. Ericson, T. E. O. (CERN, Geneva); Huefner, J. Phys. Lett.; 40B: No. 4, 459-62(24 Jul 1972).

The nuclear and hadronic response to the electromagnetic fields in exotic atoms causes an energy shift proportional to a sum of nuclear and hadron polarizabilities. The shifts are shown to be within present experimental precision. (auth)

49038 HARD AND SOFT PROCESSES IN HADRODYNAMICS. Kogut, J. (Inst. for Advances Study, Princeton, N. J.); Frye, G.; Susskind, L. Phys. Lett.; 40B: No. 4, 469-72(24 Jul 1972).

The consequences of a parton-parton interaction which is long range in rapidity and capable of transfering large momentum are considered. The results of our analysis for hadron-hadron inclusive processes are presented. (auth)

49039 EXCHANGE FORCES IN THE QUARK BOUND STATES AND THE ASYMPTOTIC BEHAVIOR OF FORM FACTORS. Montvay, I. (CERN, Geneva). Phys. Lett.; 40B: No. 4, 476-80(24 Jul 1972).

A Bethe–Salpeter type equation is proposed for taking into account the effects of particle exchanges between the quarks in the relativistic quark model of Feynman, Kislinger and Rayndal. The equation is explicitly soluble in the ladder approximation for zero mass exchange and it leads to asymptotically dipole-like electromagnetic form factors. (auth)

49040 SYSTEMATIC DESCRIPTION OF SEMI-INCLUSIVE CROSS SECTIONS. Suranyi, P. (Univ. of Cincinnati). Phys. Lett.; 40B: No. 4, 481-3(24 Jul 1972).

The properties of semi-inclusive cross sections are derived using unitarity and Regge-pole analysis in the three particle scattering channel and they disagree with earlier predictions if the triple-Pomeron contributions do not vanish identically. (auth)

49041 FLUX QUANTIZATION AND PARTICLE PHYSICS. Jehle, Herbert (George Washington Univ., Washington, D. C.). Phys. Rev., D; 6: No. 2, 441-57(15 Jul 1972).

Quantized flux has provided an interesting model for muons and for electrons: One closed flux loop of the form of a magnetic dipole field line is assumed to adopt alternative forms which are superposed with complex probability amplitudes to define the magnetic field of a source lepton. The spinning of that loop with an angular velocity equal to the Zitterbewegung frequency $2mc^2/\hbar$ implies an electric Coulomb field, (negative) positive, depending on (anti) parallelism of magnetic moment and spin. The model implies CP invariance. A quark may be represented by a quantized flux loop if interlinked with another loop in the case of a meson, with two other loops in the case of a baryon. Because of the link, their spinning is very different from that of a single loop (lepton). The concept of a single quark does not exist accordingly, and it is seen that a baryon with a symmetric spin-isospin function in the SU(2) × SU(3) quark representation might not violate the Pauli principle because the wave function representing the relative position of linked loops may be chosen antisymmetric. Weak interactions may be understood to occur when the flux loops involved in the interaction have to cross over themselves or over each other. Strangeness is readily interpreted in terms of the trefoil character of a λ quark: Strangeness-violating interactions imply crossing of flux lines and are thus weak and parity-nonconserving. $\Delta S = \Delta Q$ is favored in such interactions. Intrinsic symmetries may be interpreted in terms of topology of linked loops. Sections I and II give a short resume of the 1971 paper. (auth)

49042 TWIST RELATION, THIRD FACTORIZATION, AND THE GENERAL VERTEX IN A DUAL MULTIPARTICLE THEORY WITH NONLINEAR TRAJECTORIES. Baker, M. (Univ. of Washington, Seattle); Yu, S.; Coon, D. D. Phys. Rev., D; 6: No. 2, 538-46(15 Jul 1972).

The properties of the dual multiparticle theory with nonlinear trajectories are presented: (I) the twist relation, (II) the unsymmetric general vertex obtained directly from third factorization, and (III) the symmetric general vertex. (auth)

49043 SEPARABLE EXPANSION OF THREE-PARTICLE AMPLITUDES. Gal'pern, E. S.; Lyakhovitskii, V. N.; Narodetskii, I. M. (Inst. of Theoretical and Experimental Physics, Moscow). JETP Lett. (USSR) (Engl. Transl.); 15: No. 9, 385-8(5 May 1972).

Translated from Zh. Eksp. Teor. Fiz., Pis'ma Red.; 15: No. 9, 544-7(5 May 1972).

Using the simplest separable interaction as an example, certain properties of the Hilbert–Schmidt expansion for amplitudes in the three-body problem are considered. The convergence of the Hilbert–Schmidt expansion for the scattering length for n + d interactions is shown for the spinless case and also for the doublet and quartet states. (J.F.P.)

49044 INTERRELATION BETWEEN THE BACKGROUND AND RESONANCES IN INCLUSIVE DISTRIBUTIONS. Bishari, Mordechai; Yesian, Harry J. (Univ. of California, Berkeley). Phys. Rev., D; 6: No. 3, 921-4(1 Aug 1972).

It is argued that in inclusive reactions the diffractive resonance excitation of the projectile (target) generates part of the background in the target (projectile) excitation spectrum. Accelerator data show that diffraction models cannot saturate the magnitude of the observed spectra. (auth)

49045 BREAKDOWN OF HADRONIC SCALING OR EVIDENCE FOR CLUSTERING. Krzywicki, A. (California Inst. of Tech., Pasadena); Petersson, B. Phys. Rev., D; 6: No. 3, 924-8(1 Aug 1972).

It is argued that the result of a recent comparison of single-particle spectra at accelerator and cosmic-ray energies is evidence for clustering effects in individual events rather than for a breakdown of the hadronic scaling, as originally suggested. It is pointed out that clustering on rapidity plots corresponding to individual events results, as a kinematic reflection, from the small inelasticity of the through-going particles. A simple model of inclusive spectra (suggested by multiperipheralism and gas-liquid analogy), with kinematic clustering built into it from the outset, is proposed. (auth)

49046 APPLICATIONS OF THE DUAL-PARTON MODEL TO HIGH-ENERGY MULTIPARTICLE PROCESSES. Susskind, Leonard (Stanford Univ., Calif.). Phys. Rev., D; 6: No. 3, 894-900 (1 Aug 1972).

The dual-parton model of Kraemmer, Nielsen, and Susskind is reviewed and applied to high-energy production processes. Most, but not all, of the predictions are not new and have been given by many practitioners of the multiperipheral and parton models. What is new is a unified presentation of these predictions in terms of the fragmentation of the hadronic string into segments, each retaining the properties it had before collision. The method is applied to transverse-momentum distributions and correlations and to charge distributions of secondary hadrons. (auth)

49047 KINEMATICAL MODEL FOR QUARKS AND HADRONS. Biedenharn, L. C. (Duke Univ., Durham, N. C.); Cusson, R. Y.; Han, M. Y.; Louck, J. D. Found Phys.; 2: No. 2-3, 149-59 (Apr 1972).

Starting from simple topological arguments due to Dirac on the classical rotational properties of extended rigid bodies, the concept of a finite-size spinor (FSS) is extracted. The FSS is a concept distinct from both point spinors (e.g., electrons) and composite spinors (e.g., nuclei), and suggests a new model for baryons. The FSS offers a natural explanation of "threeness" for the quarks, excludes the existence of free quarks, denies the operational definition of quark spin statistics, and, moreover, leads to the dual model of hadronic interactions. (auth)

Strong (Baryon No. = 0)

Refer also to abstracts 48917, 49120, 49152, and 49224.

49048 (COO-264-601) MEASURING $\pi-\pi$ PHASE SHIFTS IN COLLIDING BEAM EXPERIMENTS. Carlson, Carl E.; Tung, Wu-Ki (Chicago Univ., Ill. Enrico Fermi Inst.). Jan 1972. Contract AT(11-1)-264. 43p. (EFI-72-5). Dep. NTIS.

The possibility of exploiting the unique features of the two photon process $ee \rightarrow ee\pi\pi$ in colliding beam experiments to measure the even partial wave $\pi-\pi$ phase shifts is examined in detail. The commonly used Weizsäcker–Williams approximation is shown to be inadequate. An exact procedure of phenomenological analysis to extract the relevent phase shifts is formulated. Dynamical (model-dependent) calculations are performed separately to study the expected effects due to the final state pion–pion interaction. The sensitivity of the measured cross sections to various prominent features of the s-wave $\pi-\pi$ phase shifts (scattering length, existence of scalar meson resonance) is investigated. (auth)

49049 (N-71-15897) s-WAVE l = 0 PION-PION RESONANCE. Gore, Bryan F. (Maryland Univ., College Park. Dept. of Physics and Astronomy). Aug. 1970. 50p. (NASA-CR-116135). NTIS.

Solutions are presented for subtracted dispersion relations, written for the s and p-wave inverse pion-pion scattering amplitudes with (CDD) poles inserted into both s-waves. These solutions predict the existence of a super broad l = 0 s-wave resonance (sigma) accompanied by a small, negative l = 2 phase shift, in the absence of any s-wave experimental input whatsoever. While p-wave subtraction parameters are adjusted to fit a 755-MeV rho resonance with width 120 MeV, the s-wave parameters are determined by crossing symmetry through derivative conditions to third order. (auth)

49050 (SU-4205-261) PHYSICAL REGION CONSTRAINTS FOR π-π LOW ENERGY PARAMETERS. Balachandran, A. P.; Blackmon, Maurice L.; Sigaud, Cassio (Syracuse Univ., N. Y. Dept. of Physics). Mar 1972. 8p. (NYO-3533-261). Dep. NTIS.

Sum rules of the following type were derived for π-π scattering in previous literature: (1) sum rules for the s-wave effective ranges and the p-wave scattering length in terms of π-π total cross sections $\sigma_t^{(I)}$ and the s-wave scattering lengths; (2) sum rules for the d-wave scattering lengths $a_2^{(I)}$ in terms of $\sigma_t^{(I)}$ and the diffraction peak widths $W^{(I)}$; (3) a sum rule involving only $\sigma_t^{(I)}$ and $W^{(I)}$. It is shown that these results are simple consequences of an equation due to Roy which implies in addition a sum rule for the p-wave effective range in terms of $\sigma_t^{(I)}$. It is also shown how to convert (2) into inequalities for $a_2^{(I)}$ in terms of $\sigma_t^{(I)}$. (auth)

49051 PROPOSED 3^- RECURRENCE OF THE 1^- NONET. Graham, R. H.; Yoon, T. S. (Univ. of Toronto). Phys. Rev., D; 6: No. 1, 336-40(1 Jul 1972).

A $J^P = 3^-$ nonet consisting of the states $\rho(1670)$, $\omega(1680)$, $K^*(1760)$, and $\phi(1820)$ is proposed. These mesons are taken to be the Regge recurrences of the 1^- nonet, and their various decays into 0^- and 1^- mesons are studied. A consistent scheme emerges, in which the 3^- nonet and its couplings to the lower-lying mesons may be described in terms of SU(3) symmetry and the quark model. Of particular interest is the result that the isosinglet members of the 3^- nonet appear to mix "ideally." (auth)

49052 SOLUTIONS TO $\pi-\pi$ and $K-\pi$ SCATTERING IN A MODEL SATISFYING ANALYTICITY, CROSSING SYMMETRY, AND APPROXIMATE UNITARITY. Moffat, J. W.; Weisman, B. (Univ. of Toronto). Phys. Rev., D; 6: No. 1, 238-50(1 Jul 1972).

Phase shifts for $\pi-\pi$ and $K-\pi$ scattering are obtained from a model satisfying analyticity, exact crossing symmetry, and approximate unitarity up to $\sqrt{s} \sim 1.3$ GeV. Low-energy elastic as well as low- and high-energy total cross sections are calculated. The results are compared with available data on $\pi-\pi$ and $K-\pi$ scattering, as well as general restrictions on $\pi-\pi$ models. (auth)

49053 ZERO PION MASS LIMIT IN INTERACTION AT VERY HIGH ENERGIES. Anselm, A. A.; Gribov, V. N. (Ioffe Inst. of Physics and Tech., Leningrad). Phys. Lett.; 40B: No. 4, 487-90 (24 Jul 1972).

It is supposed that, similarly to the situation at small energies, the hadronic amplitudes at high energies do not tend to infinity within the limit of vanishing pion mass. In this limit some specific phenomena arise, one of which, the appearance of the singularity in the trajectories of the Regge-poles, is discussed. It is shown that the increase of the slope of the diffraction peak at small $-t$, observed in ISR experiments, can be explained, in the order of magnitude, with the help of the theory exploiting the small value of the pion mass. A (20−40)% decrease of the slope of ρ-trajectory at $t = 0$ is predicted as compared to the slope at $-t \gg 4\mu^2 \approx 0.08$ GeV^2. (auth)

49054 INEQUALITIES FOR THE PION–PION PARTIAL WAVES: GENERAL CONSIDERATIONS AND NEW INEQUALITIES. Balachandran, A. P. (Syracuse Univ., N. Y. Istituto Nazionale di Fisica Nucleare, Naples); Blackmon, Maurice L. Phys. Rev., D; 6: No. 2, 631-9(15 Jul 1972).

A class of inequalities for the pion-pion s and p waves has been discussed in a series of recent papers. The present work attempts to provide a systematic method for writing such inequalities. An infinite number of new inequalitites for the pion-pion s and p waves are also derived. (auth)

49055 s-WAVE I = 0 $\pi\pi$ RESONANCE. Gore, Bryan F. (Univ. of Maryland, College Park. Central Washington State Coll., Ellensburg). Phys. Rev., D; 6: No. 2, 666-77(15 Jul 1972).

Solutions are presented for subtracted dispersion relations, written for the s- and p-wave inverse $\pi\pi$ scattering amplitudes with poles inserted into both s waves. These solutions predict the existence of a broad I = 0 s-wave resonance (σ) accompanied by a small, negative I = 2 phase shift, in the absence of any s-wave experimental input. While p-wave subtraction parameters are adjusted to fit a 755-MeV ρ resonance with width 120 MeV, the s-wave parameters are determined by crossing symmetry through derivative conditions to third order. The coupling constant, λ, is a free parameter, and resonant solutions are obtained for $-0.033 \leq \lambda \leq 0.040$ with σ masses ranging from 550 to 900 MeV. Both s-wave amplitudes exhibit zeros between the cuts for $-0.01 < \lambda < 0.02$, and for $\lambda = -0.008$ the zeros coincide with those predicted by the Adler condition applied on the mass shell. Solutions with $\lambda \lesssim -0.01$ satisfy crossing conditions for $\pi^0\pi^0$ amplitudes. The failure of the other solutions to satisfy them may be related to approximations made in applying crossing symmetry. A method of improving the solutions is suggested. (auth)

49056 CHIRAL SYMMETRY BREAKING AND THE DUAL PION MODEL. Schwarz, John H.; Wallace, D. J. (Princeton Univ., N. J.). Phys. Rev., D; 6: No. 2, 723-5(15 Jul 1972).

It has been previously shown that a zero-slope limit of the dual pion model with $m_\pi = 0$ is equivalent to the SU(2) ⊗ SU(2)-symmetric nonlinear σ model. This result is extended by showing that an appropriately defined zero-slope limit of the dual pion model with $m_\pi \neq 0$ exists and corresponds to the nonlinear σ model with $(\frac{1}{2},\frac{1}{2})$-symmetry breaking. (auth)

49057 INVESTIGATION OF THE PARADOX OF EINSTEIN, PODOLSKY, AND ROSEN FOR ULTRASMALL SPACE–TIME INTERVALS. Fox, Raymond (Technion-Israel Inst. of Tech., Haifa). Phys. Rev., D; 6: No. 2, 413-18(15 Jul 1972).

It is demonstrated that the Einstein−Podolsky−Rosen paradox (EPRP) can be investigated for ultrasmall space-time intervals by a reaction called "proximity correlation." One of the examples of proximity correlation analyzed in detail is the emission from a state J = 0 of two spin-1 particles, A and B, in a relative orbital angular momentum state L = 1, A and B decaying subsequently into spin-0 particles. It is shown that the quantity of interest in EPRP, $C(\vec{a},\vec{b})$, the probability of particle A having polarization $M_{S_A} = 0$ with respect to $\vec{a}$, and particle B having polarization $M_{S_B} = 0$ with respect to $\vec{b}$, is predicted according to quantum mechanics as being $C(\vec{a},\vec{b}) \equiv C(\theta) \propto \sin^2\theta$. It is further shown that this relation can be tested experimentally by the decay of a $0^-(J^P)$ meson into two vector mesons. Experimental details are discussed. (auth)

49058 CROSSING AND POSITIVITY PROPERTIES OF PARTIAL WAVES. A REVIEW. Balachandran, A. P. pp 6-23 of Mathematical Problems in Theories of Particles and Fields. Goteborg; Chalmers Tekniska Hogskola (1971).

From Mathematical problems in theories of particles and fields conference; Goteborg, Sweden (7 Jun 1971). See CONF-710650; CTH-ITP-71-16.

Crossing symmetry of the scattering amplitude is used to derive an infinite number of sum rules each of which involves a finite number of partial waves. Such sum rules exist for four-body processes where the particles have arbitrary mass and spin and for N-body processes (N ≥ 5) where the particles have arbitrary mass and no spin. These sum rules lead to an infinite number of inequalities involving the s- and p-$\pi\pi$ partial waves when certain positivity properties of the $\pi\pi$ partial waves proved by Martin are used. The generalization of such positivity statements to certain processes which involve particles with spin and unequal mass (for example, the process $\pi N \rightarrow \pi N$) is also possible. The use of these results in the construction of theoretical models for partial waves is discussed. (auth) (Sweden)

49059 WHAT ARE THE π-π SCATTERING LENGTHS? Brandt, Richard A. (New York Univ., N. Y.); Kaufman, Alfred; Valenti, Giovanni; Preparata, Giuliano. Phys. Rev., D; 6: No. 3, 828-34(1 Aug 1972).

Weinberg has calculated the π-π scattering lengths assuming current algebra, $(3,\bar{3})$-symmetry breaking, an expansion to first order in the squared energies s, t, u and mass variables q_i^2, and a strong form of pion-pole dominance. It is shown that essentially the same scattering lengths are obtained if the strong pion-pole dominance and expansion in q_i^2 assumptions are replaced by a much weaker form of pion-pole dominance. Canonical light-cone and Regge-pole assumptions and techniques are used in the calculation. (auth)

49060 CURRENT ALGEBRA, THE TRIANGLE APPROXIMATION, AND MESON DECAYS. Scadron, M. D.; Thews, R. L. (Univ. of Arizona, Tucson). Phys. Rev., D; 6: No. 3, 844-51 (1 Aug 1972).

Axial-vector-current conservation in a world of massless pions is used to investigate two-body decays of vector and tensor mesons involving at least one pion. The axial-vector channel is saturated with the single-pion and $B\bar{B}$ intermediate states, which leads to absolute predictions for vector-meson decay rates, with no adjustable parameters. Good agreement with experiment is found for $\omega \rightarrow \pi\gamma$ and $\rho \rightarrow \pi\pi$. Comparisons with the vector-meson-dominance model and ρ-meson universality are made. The model is extended to tensor-meson decays, and vector-tensor exchange degeneracy is found. (auth)

Strong (Baryon No. = 1)

Refer also to abstracts 48920, 48923, 49118, and 49233.

49061 (DESY–72/25) THEORETICAL ESTIMATE OF THE MESON NUCLEON SIGMA TERMS. Renner, B. (Deutsches Elektronen-Synchrotron, Hamburg (West Germany)). May 1972. 6p. Dep. NTIS (U. S. Sales Only).

The mechanism of Li and Pagels is used to predict the meson nucleon sigma terms in the framework of the $(3,3^x) + (3^x,3)$ model of chiral symmetry breaking. (auth)

49062 (JINR–P1-6488) TECHNIQUE OF CROSS SECTION DETERMINATION ACCORDING TO THE RESULTS OF FINAL STATES SEPARATION. Volod'ko, A. G.; Karamyan, Zh. K.; Kharzheev, Yu. N.; Shandor, L. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Nuclear Problems). 1972. 40p. (In Russian). Dep. NTIS (U. S. Sales Only).

A technique is presented for identification of the reaction channels and determination of cross sections using the obtained (by modelling) "transmission" coefficients (η_{ij} or κ_{ij}) and then solving the corresponding systems of equations. (auth)

49063 (ORO–3992-95) MESON–BARYON ELASTIC POLARIZATION AND THE REAL PART OF THE NONFLIP AMPLITUDE. Chiu, C. B. (Texas Univ., Austin. Center for Particle Theory); Wada, W. W. (European Organization for Nuclear Research, Geneva (Switzerland). Ohio State Univ., Columbus. Dept. of Physics). 20 Jun 1972. 20p. Dep. NTIS.

The strong central absorption prescription for the nondiffractive helicity-nonflip elastic two-body scattering amplitude, that has recently been proposed, is discussed briefly, and the experimental indications for this in the crossing even πp and $K^- p$ scattering amplitudes are presented. The strong and weak versions of the prescription are also presented. (auth)

49064 (RHEL/R-245, pp 1-14) PARTIAL WAVE ANALYSIS OF QUASI-TWO BODY REACTIONS. Litchfield, P. J. (Rutherford High Energy Lab., Chilton, Eng.).

From Meeting on future work in $K^\pm$ strong interaction physics below 5 GeV/c; Chilton, England (19 Nov 1971).

It is stated to be a characteristic of K^- induced reactions that there are several strong quasi-two body reactions, such as $K^- p \rightarrow \Lambda\omega$, $K^- p \rightarrow NK^*(890)$, and $K^- p \rightarrow \Sigma(1385)\pi$. These offer an opportunity for extension of knowledge of the strangeness —1 system by the study of new channels. Data and their analysis are described for experimental work by the College de France—RHEL—Saclay—Strasbourg Collaboration comprising bubble chamber K^- formation in the momentum range 1.26 to 1.84 GeV/c. Analysis of the $\Lambda\omega$ channel is complete; results for the K^*N and $\Sigma(1385)\pi$ channels are preliminary and these analyses are still in progress. 2 references. (UK)

49065 (RHEL/R-245, pp 15-17) PARTIAL WAVE ANALYSIS OF $K^- n \rightarrow \pi^- \Lambda$ BETWEEN 1.9 AND 2.2 GeV. Cox, G. F. (Univ. of Birmingham, Eng.).

From Meeting on future work in $K^\pm$ strong interaction physics below 5 GeV/c; Chilton, England (19 Nov 1971).

Reference is made to new data on this reaction obtained from 135 K pictures of 1.78-GeV/c K^- in the CERN 2m DBC and also 60K events selected as being likely neutron interactions observed on the Birmingham HPD. Combining these new data with data from 1.45 and 1.65 GeV/c an energy dependent partial wave analysis of the reaction between 1.9 and 2.2 GeV was made. The main purpose of the analysis was to investigate the resonance $\Sigma(2080)$ with $J^P = 3/2^+$. 1 reference. (UK)

49066 (RHEL/R-245, pp 29-45) THEORY VERSUS EXPERIMENT IN Y* SPECTROSCOPY. Moorhouse, R. G. (Univ. of Glasgow).

From Meeting on future work in $K^\pm$ strong interaction physics below 5 GeV/c; Chilton, England (19 Nov 1971).

It is stated that in discussing theory and experiment in Y^* spectroscopy a guide is available outside the observed Y^* phenomena in the observed N^* and Δ resonances, which by SU3 must have their Y^* counterparts in octets and decuplets. This is particularly helpful since, despite much recent experimental work and partial wave analysis in the Y^* systems, knowledge of the N^*s and Δs, including J^P assignments, is still more complete than that of the Λs and Σs: The L-excitation quark model in its symmetric form is taken seriously, and the relevant multiplets of SU 6 × 03 are discussed, taking the harmonic oscillator shell model wave functions as a guide. Amongst matters discussed are the 70, $L = 1^-$ multiplet, corresponding assignments for the $N = 2$ positive parity multiplets, and resonance decays into vector mesons. 34 references. (UK)

49067 (RHEL/R-245, pp 47-60) $\overline{K}N$ PARAMETERIZATIONS BELOW 2 GeV/c. Martin, B. R. (University Coll., London).

From Meeting on future work in $K^\pm$ strong interaction physics below 5 GeV/c; Chilton, England (19 Nov 1971).

A brief survey is given of current methods used in analyzing $\overline{K}N$ data below 2 GeV/c, and some results of these methods are discussed. 15 references. (auth)

49068 (RHEL/R-245, pp 115-32) APPLICATION OF THE CUTCOFSKY-DEO METHOD TO K^+p ELASTIC SCATTERING. de Roo, M.; Wagner, F. (Max-Planck-Institut fuer Physik und Astrophysik, Munich).

From Meeting on future work in $K^\pm$ strong interaction physics below 5 GeV/c; Chilton, England (19 Nov 1971).

A short account is given of the application of an expansion of the scattering amplitude from threshold to 2.5 MeV/c in terms of variables obtained by a conformal mapping of the scattering angle $\cos\theta$. The usual expansion into legendre polynomials converges inside an ellipse whose size is determined by the thresholds in the crossed channels, but as proposed by Cutcopsky and Deo (Phys. Rev. 174: 1859 (1968)) a larger domain of convergence is obtained by using a new variable $Z(\cos\theta)$, where the cuts in $\cos\theta$ are mapped on the boundary of the convergence ellipse. Due to this improved convergence fewer Z terms are needed to approximate the amplitude with the same accuracy than in $\cos\theta$. Compared to a conventional analysis the CD method reduces substantially the ambiguity at each energy. 8 references. (UK)

49069 (RHEL/R-245, pp 163-86) K^+n BACKWARD DISPERSION RELATIONS. Nielsen, H.; Oades, G. C. (Rutherford High Energy Lab., Chilton, Eng.).

From Meeting on future work in $K^\pm$ strong interaction physics below 5 GeV/c; Chilton, England (19 Nov 1971).

Various sets of K^+p phase shifts were studied for consistency with backward dispersion relations. Some useful information was also obtained for ϵ, ρ, and ω couplings to the $K\overline{K}$ and $N\overline{N}$ channels. The formalism is outlined, approximations are detailed, and a model is introduced. An examination is made as to the fitting of various K^+p phase shift solutions to this model. It is shown that a similar model provides an excellent description of πN backward scattering, and conclusions are drawn concerning the various coupling constants. 22 references. (UK)

49070 (RHEL/R-245, pp 187-97) PARTIAL-WAVE DISPERSION RELATION ANALYSIS OF K^+p SCATTERING BELOW 1.3 GeV/c. Martin, B. R.; Miller, C. E. (University Coll., London).

From Meeting on future work in $K^\pm$ strong interaction physics below 5 GeV/c; Chilton, England (19 Nov 1971).

Elastic K^+p scattering data below 1.3 GeV/c were analyzed using an energy-dependent parameterization based on partial-wave dispersion relations. Amplitudes for the s and p-wave interactions are presented. 25 references. (auth)

49071 (RPP/T-16) SHORT RANGE πN P-WAVE INTERACTIONS. COMPARISON WITH HIGH ENERGY BACKWARD REGGE MODELS. Elvekjaer, F. (Rutherford High Energy Lab., Chilton (England)). 1972. 22p. Dep. NTIS (U. S. Sales Only).

Using the nonreduced discrepancies the P-wave forces are divided into long- and short-range parts. The long-range t-channel forces of the nonreduced P-waves are shown to be adequately described by ρ^- and σ^- exchange. The short-range parts are related to high energy backward scattering. The comparison with the usual Regge model shows a large inconsistency in the isospin ½ amplitudes. The implications of this inconsistency are discussed in connection with the recent high energy data on πN backward scattering. (auth)

49072 HIGH-ENERGY TOTAL CROSS SECTIONS AND SYMMETRY RELATIONS. Coyne, J. Joseph; Meshkov, Sydney (National Bureau of Standards, Washington, D. C.). Phys. Rev., D; 6: No. 1, 399-402(1 Jul 1972).

Recent Serpukhov measurements of meson-baryon total cross sections allow comparisons with the Johnson—Treiman and Barger—Rubin relations. For 25 to 55 GeV/c incident meson momenta, the Johnson—Treiman relation, $\frac{1}{2}\Delta(Kp) = \Delta(\pi p)$, is well satisfied. The less restrictive Barger—Rubin relation holds for most of the Serpukhov points. Linear extrapolation of Serpukhov fits for $\Delta(Kp)$ and $\Delta(\pi p)$ to high momenta leads to the prediction of large violations of the Johnson—Treiman relations. (auth)

49073 NEW ISOSPIN PREDICTIONS FOR ONE- AND TWO-PARTICLE INCLUSIVE REACTIONS. Macfarlane, A. J. (Northern Illinois Univ., DeKalb. Argonne National Lab., Ill.). Phys. Rev., D; 6: No. 1, 326-8(1 Jul 1972).

Let the known result giving the ν_C dependence of $\sigma(\nu_C)$ for inclusive $A + B \rightarrow C + X$ be called a one-particle distribution in isospin space, where $\nu \equiv I_Z$. The corresponding two- or many-particle distributions are derived. It gives the ν_C, ν_D dependence of $\sigma(\nu_C, \nu_D)$ for inclusive $A + B \rightarrow C + D + X$, and the ν_A, ν_B, ν_C dependence of the cross section for $A + B \rightarrow C + X$. Applications include new cross section relations for $\bar{p} + d \rightarrow \pi + \Delta + X$ and $N + p \rightarrow \Delta + X$. (auth)

49074 MOMENT ANALYSES OF $\pi N \rightarrow (\pi\pi)N$ AND $\pi N \rightarrow (\pi\pi)\Delta$ FOR $\pi\pi$ PHASE SHIFTS. Williams, P. K. (Florida State Univ., Tallahassee). Phys. Rev., D; 6: No. 1, 174-6(1 Jul 1972).

Recent experiments on $\pi N \rightarrow (\pi\pi)N$ and $\pi N \rightarrow (\pi\pi)\Delta$ should yield new information on $\pi\pi$ phase shifts. The extrapolation to the pion pole of the moments $\langle Y_1^m \rangle$ of the $\pi\pi$ angular distributions is discussed in terms of a model incorporating absorptive effects which gives simple closed expressions for the moments in terms of on-shell $\pi\pi$ phase shifts, thus facilitating the extraction of this information from the data. (auth)

49075 RESONANCE OVERLAP AND THE ENERGY DEPENDENCE OF EXOTIC EXCHANGE PROCESSES. Gage, D. W.; O'Donovan, P. J. (Arizona State Univ., Tempe). Phys. Rev., D; 6: No. 1, 377-9(1 Jul 1972).

When the observed total widths of baryon resonances are inserted into leading terms of the Veneziano model via the "Imα" prescription, quantitative agreement with the rapid s variation of exotic-exchange forward differential cross sections is obtained, supporting a resonance overlap interpretation of the effect. (auth)

49076 LINEAR-TRAJECTORY FITS OF PION-NUCLEON SCATTERING AT HIGH ENERGIES. Gleiser, R. J. (Univ. Nacional, Cordoba, Argentina); Gleeson, A. M. Phys. Rev., D; 6: No. 1, 262-80(1 Jul 1972).

A simple Regge model for high-energy pion-nucleon scattering is investigated. The trajectory parameters of this model are completely determined by the spins and masses of the particles lying on them. The necessity for bending the trajectories is avoided in order to reproduce the observed high-energy dependence of the differential cross sections by not assuming that the continued partial-wave amplitudes satisfy Mandelstam symmetry. The absence of this symmetry gives rise to extra terms in the asymptotic form of a given amplitude. These extra terms are unambiguously determined by the model, and do not require further parametrization or physical interpretation. An explicit example is given showing that in relativistic scattering, Mandelstam symmetry is not a necessary consequence of the Froissart-Gribov representation. This model is tested by fitting all the available high-energy pion-nucleon scattering data with experiment. An extended version of this model predicts, for forward pion-nucleon charge-exchange scattering, a nonzero polarization with only ρ exchange. (auth)

49077 σ TERM IN KN SCATTERING. Reya, E. (Florida State Univ., Tallahassee). Phys. Rev., D; 6: No. 1, 200-3(1 Jul 1972).

The magnitude of the nucleon expectation value of the σ commutator for KN scattering was calculated using KN phase shifts and fixed-t dispersion relations. The result agrees with most of the recent calculations for πN scattering, but is smaller than the estimate by Cheng and Dashen, and is in favor of the $(3, \bar{3}) + (\bar{3}, 3)$ model for chiral symmetry breaking. (auth)

49078 ESTIMATES OF INVARIANT AMPLITUDES FOR REACTIONS WITH rho EXCHANGE. Randa, J. (Univ. of Illinois, Urbana). Phys. Rev., D; 6: No. 1, 251-6(1 Jul 1972).

The hypothesis that ρ-exchange invariant amplitudes for different reactions have the same ratio in the scattering region as they do at the ρ pole is considered. The hypothesis is found to be in reasonable agreement with existing data. It can then be used to predict, to within a factor of about 2, the size of ρ-exchange cross sections in future experiments. (auth)

49079 MISSING PARITY PARTNERS ON BARYON TRAJECTORIES. Chylek, Petr (Indiana Univ., Bloomington). Phys. Rev., D; 6: No. 1, 383-4(1 Jul 1972).

Using the quark model it is shown that the mechanism responsible for the fact that the lowest baryons do not have opposite parity partners is different for the case of the nucleon and for the P_{33} resonance. (auth)

49080 TEST OF FACTORIZATION IN THE TWO-PARTICLE INCLUSIVE REACTIONS, $\pi^+p \rightarrow \pi^-\pi^-X$ AND $pp \rightarrow \pi^-\pi^-X$. Lam, W. S. (University Coll., London). Phys. Lett.; 40B: No. 4, 466-8(24 Jul 1972).

Evidence is presented for factorization of the two-particle inclusive reactions $\pi^+p \rightarrow \pi^-\pi^-X$ at 18.5 GeV/c and $pp \rightarrow \pi^-\pi^-X$ at 21 GeV/c in the fragmentation region of the target proton. (auth)

49081 THEORETICAL ESTIMATE OF THE MESON NUCLEON SIGMA TERMS. Renner, B. (Univ., Hamburg). Phys. Lett.; 40 B: No. 4, 473-5(24 Jul 1972).

The mechanism of Li and Pagels is used to predict the meson nucleon sigma terms in the framework of the $(3,3^x) + (3^x,3)$ model of chiral symmetry breaking. (auth)

49082 CONNECTION OF PARABOLIC MASS AND WIDTH TRAJECTORIES WITH HIGH-ENERGY SCATTERING. Ingraham, R. L. (New Mexico State Univ., Las Cruces). Phys. Rev., D; 6: No. 1, 329-35(1 Jul 1972).

An infinite sequence of direct-channel resonances is explicitly summed by the Sommerfeld–Watson method. This is quite different from the problem heretofore considered of summing t-channel resonances and requires different physical assumptions. In fact, the "parabolic" mass trajectory $\mu_J \propto J$ and a slow growth of width (on resonance) $\Gamma_J \propto J$ as $J \rightarrow \infty$ are necessary to reproduce in the Regge limit the form const × $J_{\Delta\lambda}(R\sqrt{-t})$. $R \equiv$ interaction range, $\Delta\lambda \equiv$ total helicity change, for the imaginary part of this (nondiffractive) part of the c.m. two-body reaction amplitude, in agreement with experiment, and Harari's qualitative theory, for πN and KN entrance channels. The above width ansatz is of central importance in the derivation and is also experimentally supported. Linear and parabolic mass trajectories in the direct channel are compared. Small s-dependent deviations from fixed crossover $-t \approx 0.2$ (GeV/c)^2 and first dip $-t \approx 0.6$ (GeV/c)^2 points are predicted. (auth)

49083 QUARKS, SUM RULES, AND LOW-ENERGY PARAMETERS IN πN SCATTERING. Dias de Deus, J. (University Coll., London). Phys. Rev., D; 6: No. 1, 318-25(1 Jul 1972).

Finite-energy sum rules and current-algebra sum rules are shown to work at the quark level. Making use of these rules, and of a factorization assumption for the basic meson-quark amplitudes above threshold, some well-known SU(6) results are derived. Low-energy parameters in πQ and πN scattering are also evaluated. Using the model for the πN $a_{1\pm}^{(-)}$ p-wave scattering lengths, an inconsistency is found between the usual PCAC (partially conserved axial-vector current) or ρ-exchange-model treatments and dispersion relations. It can be removed if double counting of resonances and ρ-exchange terms is avoided. This provides good agreement with experiment. (auth)

49084 SCALE AND CONFORMAL TRANSFORMATIONS OF CURRENTS AND TENSOR-MESON DOMINANCE. Genz, H. (Univ., Karlsruhe, Ger.); Katz, J.; Ram Mohan, L. R. Phys. Rev., D; 6: No. 2, 624-31(15 Jul 1972).

The infinite-momentum limit and single-particle saturation are used to investigate consequences for baryon matrix elements of equal-time commutators of the generators of scale and conformal transformations with currents and their divergences. It is shown that the root-mean-square tensor mass radii are the same for all members of the baryon octet. Regge theory is used to show the validity of the procedure in this case. The result implies that some of the baryon gravitational form factors $F_1^B(q^2)$ or $F_2^B(q^2)$ must be subtracted. On demanding the subtractions to be SU(3)-symmetric $G_2(fNN)/G_1(fNN) = -1$ is obtained and the f/d ratios are found to be the same for the two couplings. This is in agreement with the phenomenological analyses of Schlaile and of Strauss. (auth)

49085 CONSEQUENCES OF LOCAL DUALITY IN $\bar{K}$N SCATTERING. King, Marcia J. (Syracuse Univ., N. Y.); Shah, Prakash M.; Wali, Kameshwar C. Phys. Rev., D; 6: No. 1, 229-38(1 Jul 1972).

Local duality conditions imply relations between coupling constants for sets of particles degenerate in mass but differing in spins, parities, and SU(3) assignments. A particular solution was examined in the exact SU(3) limit and the results were used to calculate partial widths of the resonances for decays into the $\bar{K}$N channel. Broken SU(3) symmetry is incorporated by using physical masses to calculate phase-space and barrier factors. Cross sections coming from the contributions of the resonances alone were computed for the reactions $K^-p \rightarrow K^-p$ and $K^-p \rightarrow \bar{K}^0n$ for the center-of-mass energy range 1.720–1.930 GeV. There is good over-all agreement with experimental results, including the peaks in the backward differential cross sections for both reactions. (auth)

49086 S_{11}–P_{11} PHASE SHIFTS OF PION–NUCLEON SCATTERING. Barron, Robert Henderixson. Philadelphia; Temple Univ. (1972). 101p. University Microfilms Order No. 72-17,679.

Thesis.

A phase shift analysis of the S_{11} and P_{11} partial waves is performed by means of the N/D method. The analysis differs from others made previously in the way of including inelasticity and the handling of short-range forces. One can obtain the nucleon as a bound state with the correct mass and residue. Also agreement is obtained with the P-wave phase shifts and absorption coefficients and the P-wave and S-wave scattering lengths. However, agreement is not obtained with the S-wave phase shifts at higher energies unless a CDD pole is added on the S-wave side of the W-plane. Several arguments are given as to why a CDD pole is necessary. Also the method used and the Frye–Warnock method of solving N/D equations are compared, and it is found that in many cases the two methods are not equivalent. Also discussed is the question of the equivalence between using the W-plane and using the s-plane in calculating a scattering amplitude. (Diss. Abstr. Int., B)

49087 CONFORMAL SYMMETRY AND SINGLE-MESON PRODUCTION. O'Donnell, P. J.; Ouellett, C. (Univ. of Toronto). Phys. Rev., D; 6: No. 3, 851-5(1 Aug 1972).

The results of combining conformal invariance and chiral symmetry are given for the process $\pi N \rightarrow \pi\pi N$. It is shown that if the symmetries are broken spontaneously the data are insufficient to determine the scale of the breaking term. The $\pi\pi$ scattering lengths remain small although both a_0 and a_2 are altered substantially. (auth)

49088 FIXED-t DISPERSION RELATIONS AND POLARIZATION IN PION–NUCLEON CHARGE-EXCHANGE SCATTERING. Ghandour, G. I. (Univ. of California, Berkeley); Moorhouse, R. G. Phys. Rev., D; 6: No. 3, 856-9(1 Aug 1972).

The real parts of the pion-nucleon charge-exchange amplitudes are evaluated using fixed-t dispersion relations with the imaginary parts of the amplitudes found at low energy from partial-wave analysis and at high energy from a simple s-channel absorptive model. It is found that the calculated polarization, though quantitatively somewhat small, has all the correct qualitative features. (auth)

49089 SUPERCONVERGENCE RELATIONS FOR INCLUSIVE REACTIONS. Finkelstein, J. (Stanford Univ., Calif.). Phys. Rev., D; 6: No. 3, 931-4(1 Aug 1972).

Sum rules for inclusive reactions, which are the analogs of superconvergence relations for two-body reactions, are discussed.

A local-saturation approximation to one of these sum rules yields $(d\sigma/dt)_{\pi^+p\to\pi^0\Delta^{++}} = {}^3\!/_2(d\sigma/dt)_{\pi^-p\to\pi^0n}$, which is in good agreement with experiment. (auth)

49090 EVIDENCE AGAINST RESONANCE SATURATION IN FINITE-ENERGY SUM RULES OF NON-POMERANCHUKON AMPLITUDES. Kogitz, S.; Lee, P.; Logan, R. K. (Univ. of Toronto). Phys. Rev., D; 6: No. 3, 935-7(1 Aug 1972).

A quantitative test of the basic tenet of Freund–Harari duality that resonances completely account for the non-Pomeranchukon amplitudes is made by comparing the values of finite-energy-sum-rule integrals, using both phase shifts and resonance saturation. Evidence for a background contribution to the πN I = 1 t-channel amplitudes is found, suggesting a possible breaking of duality. (auth)

49091 FOUR-VECTORS AND HELICITY AMPLITUDES IN piN ELASTIC SCATTERING. Krase, L. D.; Good, R. H. Jr. (Ames Lab., Iowa. Iowa State Univ., Ames). Phys. Rev., D; 6: No. 3, 937-8(1 Aug 1972).

There is a natural way to introduce a set of four orthogonal four-vectors in the elastic scattering process. In the πN elastic problem, they provide a covariant description of the helicity-flip and -nonflip processes. The nonflip interaction operator becomes a rotation through the scattering angle θ about the normal to the scattering plane; the helicity-flip interaction involves a rotation through $\pi + \theta$. (auth)

49092 RESONANCE DECAYS INVOLVING TWO PARTIAL WAVES. Petersen, W. P. (Univ. of Minnesota, Minneapolis); Rosner, J. L. Phys. Rev., D; 6: No. 3, 820-4(1 Aug 1972).

Resonance decays involving two partial waves, such as $B \to \omega\pi$, can test for basic violations of $SU(6)_W$. A formalism is presented for carrying out these tests using available data on $\pi N \to \pi\Delta(1236)$ and $K^-p \to \pi Y_1^*(1385)$. (auth)

49093 SOME CONSEQUENCES OF A PIECEWISE-ANALYTIC SCATTERING AMPLITUDE. Gundzik, M. G.; Sudarshan, E. C. G. (Univ. of Texas, Austin). Phys. Rev., D; 6: No. 3, 798-806(1 Aug 1972).

In the indefinite-metric quantum field theory formulated by one of the authors and in related work the scattering amplitude does not satisfy the usual Mandelstam analyticity. It becomes piecewise analytic at the threshold for the production of at least one of the negative-metric particles of the theory, i.e., the amplitude above the threshold is not the analytic continuation of the amplitude. Some consequences of such a piecewise-analytic scattering amplitude are investigated. The physical two-body scattering amplitude G(s,t) is taken to be of the form $G(s,t) = F(s,t) + h_1(s,t)\theta(s - s_0) + h_2(s,t)\theta(t - t_0) + h_3(s,t)\theta(u - u_0)$, where F(s,t) and the $h_i(s,t)$ are analytic functions of s and t with the negative-metric thresholds occurring at $s = s_0$, $t = t_0$, and $u = u_0$ in the s, t, and u channels, respectively. The modified forms of the Pomeranchuk theorem, dispersion relations, and finite-energy sum rules due to this general form of piecewise analyticity are derived and the interpretation of experimental results in terms of them are discussed. In particular, the modified forward dispersion relations for π^+p and π^-p scattering differ from the normal forms by a function $\xi(\nu)$ which depends on the piecewise-analytic contributions $h_i(s,t)$ above, where ν is the laboratory momentum of the pion. The forward dispersion relations for the symmetric and antisymmetric combinations of the real part of the π^+p and π^-p scattering amplitudes $D^+(\nu)$ and $D^-(\nu)$, respectively, are tested. The best fits to the latest total cross-section data for $\pi^\pm p$ scattering from 8 to 65 GeV/c which do not satisfy the Pomeranchuk theorem are used. No test for $D^-(\nu)$ which must be twice subtracted is possible since it depends strongly on the πN coupling constant f^2 which is itself determined by dispersion relations. The result for $D^+(\nu)$ allows for a violation, but the evidence is not compelling. (auth)

49094 PHENOMENOLOGY BASED ON TACHYON EXCHANGE. Gleeson, A. M. (Univ. of Texas, Austin); Gundzik, M. G.; Sudarshan, E. C. G.; Pagnamenta, Antonio. Phys. Rev., D; 6: No. 3, 807-13(1 Aug 1972).

The observation that the existence of tachyonic resonances can lead to peaks in differential cross sections implies a phenomenology of high-energy processes. A large class of hadronic differential cross sections shows a common peak at $-t \simeq 1.0$ $(GeV/c)^2$. A detailed fit is presented of the K^-p and π^-p charge-exchange (CEX) differential cross sections and it is determined that both processes are consistently fitted by using a tachyonic resonance with $m^2 = -1.0$ GeV^2 and $\Gamma = 580$ MeV. The spin of the resonance determines the energy shrinkage rate and is of the form $j = -\frac{1}{2} + i\sigma$. A value of $\sigma = 0.15$ leads to an adequate fit to the data. The other quantum numbers of this strongly interacting tachyon are I = 1, G parity even, and Y parity even. Other possible examples of tachyonic resonances are described. (auth)

49095 FINAL-STATE-INTERACTION CONTRIBUTIONS TO THE EXOTIC FORWARD PEAK IN $\pi^-p \to K^+Y^{*-}(1385)$. Sivers, Dennis; von Hippel, Frank (Argonne National Lab., Ill.). Phys. Rev., D; 6: No. 3, 874-84(1 Aug 1972).

The contributions to the exotic exchange reaction $\pi^-p \to K^+Y^{*-}(1385)$ in which the reaction $\pi^-p \to K^{*0}\Lambda$ feeds the $\pi^-\Lambda$ final-state interaction are calculated. The calculation contains no parameters. The final-state-interaction contribution can by itself account for the current data on the cross section and for the observed destructive interference between the K^{*0} and $Y^{*-}(1385)$ bands in the associated Dalitz plot in the final state $K^+\pi^-\Lambda$. (auth)

Strong (Baryon No. ≥ 2)

Refer also to abstract 48901.

49096 (JINR-E2-6157, pp 119-44) APPLICATIONS OF MULTIPLE SCATTERING THEORY. Kofoed-Hansen, O. (CERN, Geneva).

Using the Glauber multiple scattering theory results are presented for the computation of the double differential cross sections for proton scattering on deuterons and on heavy nuclei. Glauber scattering on deuterium, the basis for momentum spectra computations, simplified spectrum calculations, the pp input data, multiple scattering on a Fermi gas, multiple scattering expansion, nuclear inelastic scattering, and multiple nuclear excitations are treated in these lectures. (J.F.P.)

49097 (JINR-P1-6439) SEARCH FOR INVESTIGATION OF MULTIBARYON RESONANCES WITH ZERO AND DIFFERING FROM ZERO STRANGENESS. Shakhbazyan, B. A.; Timonina, A. A. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of High Energy). 1972. 14p. (In Russian). Dep. NTIS (U. S. Sales Only).

The effective mass spectra of multibaryon systems with zero and differing from zero strangeness were investigated. It is shown that the resonance peaks are observed for the systems in which total hypercharge does not exceed the unit. (auth)

49098 (UCRL-74023) Λ–Σ COUPLING AND CORE EXCITATION EFFECTS IN THE LIGHT HYPERNUCLEI. Gibson, B. F.; Goldberg, A.; Weiss, M. S. (California Univ., Livermore, Lawrence Livermore Lab.). Jul 1972. 5p. (CONF-720819--1). Dep. NTIS.

From International conference on few particle problems in nuclear interactions; Los Angeles, CA. (28 Aug 1972).

Results of a calculation in which allowance is made for the T = 1 excitation of ^{4}He are presented. These results confirm the fact that the Λ–Σ coupling is strongly suppressed in Λ-He^5. Also the consequences of this for the lambda separation energy splitting in the Λ-H^4–Λ-He^4 system are treated. (J.F.P.)

49099 NEW pp DATA AND OLD REGGE MODELS. Meldner, H. W. (Univ. of California, San Diego, La Jolla); Moellar, E. Phys. Rev., D; 6: No. 1, 390-2(1 Jul 1972).

It is shown that weak-cut-type Regge models, originally fitted to 19 ± 7 GeV/c pp data, reproduce CERN data in the 1000-GeV/c region to within about 5%. (auth)

49100 RELATIVISTIC TREATMENT OF LOW-ENERGY NUCLEON–NUCLEON SCATTERING. Bryan, R. A. (Texas A and M Univ., College Station); Gersten, A. Phys. Rev., D; 6: No. 1, 341-50(1 Jul 1972).

An improved version of the one-boson-exchange model is presented. In addition to π, ρ, ω, and X^0, the scalar mesons ϵ and δ are used with their physical masses. The broad width of the ρ and ϵ mesons is taken into account. The relativistic Blankenbecler-Sugar equation is utilized over the laboratory scattering energy range 0 to 425 MeV. A better fit to the experimental N–N data is obtained than in previous one-boson-exchange models. Reasonable values of the coupling constants are obtained, which agree qualitatively with other experiments. The fitting procedure was done including and excluding S waves in order to test the influence of the core region. An approximate version of the above model is developed using the Schrödinger equation in place of the Blankenbecler-Sugar equation. A good fit to the experimental scattering data and the deuteron parameters is obtained with coupling constants similar to those of the relativistic model. (auth)

49101 PROTON–PROTON POLARIZATION DATA: POSSIBLE EVIDENCE FOR EXOTIC PERIPHERAL RESONANCES? Chu, Shu-yuan; Hendry, Archibald W. (Indiana Univ., Bloomington). Phys. Rev., D; 6: No. 1, 190-5(1 Jul 1972).

Attention is drawn to the important fact that proton-proton polarization is very similar to π^+-proton polarization for lab momenta 3 to 17 GeV/c. In particular, there is a double zero at $|t| \approx 0.8$ $(GeV/c)^2$. This pp polarization structure is in disagreement with the expectations of simple Regge-pole schemes. Some modifications in these schemes are briefly discussed, and the possibility of peripheral resonances even in exotic channels is suggested. It is also shown how the observed pp, πp, and Kp polarizations may be interpreted in terms of an optical model. (auth)

49102 ANALYSIS OF PION–HELIUM SCATTERING FOR THE PION CHARGE FORM FACTOR. Mottershead, C. T. (Univ. of California, Berkeley). Phys. Rev., D; 6: No. 3, 780-97(1 Aug 1972).

Elastic scattering of π^+ and π^- on He^4 is analyzed for information on the charge radius of the pion using a new method based on boundary conditions near the nuclear surface. The pion radius enters the calculation via the electrostatic potential of the pion and helium charge distributions, which is assumed to be the only charge-dependent interaction. Since ^{4}He is isoscalar, the strong nuclear interaction is assumed to be charge-independent. Different cross-section data for both signs of the charge are fitted simultaneously by a program that uses the logarithmic derivatives of the pion radial wave function for each charge as free parameters. If the nuclear interaction operator is symmetric (i.e., $\langle\vec{r}'|U_N|\vec{r}\rangle = \langle\vec{r}|U_N|\vec{r}'\rangle$), the difference in the logarithmic derivative for a given partial wave resulting from changing the sign of the charge may be expressed as an integral of the internal Coulomb potential weighted by the wave function. Nuclear model dependence is greatly reduced by the constraints imposed by the empirical boundary conditions on the internal wave function. The Berkeley data at beam momenta of 130 to 163 MeV/c are analyzed by this method using both local potential and Kisslinger models for the strong interaction, and Gaussian and Yukawa pion charge distributions. The results indicate $2.2 < r_\pi < 3.2$ F, depending on the theoretical model, with an experimental precision of ~±0.5 F. In the course of the analysis, the singular-point difficulty with the Kisslinger model was examined and found to be serious. (auth)

49103 GENERALIZED DUALITY: A RELATIONSHIP BETWEEN THREE-BODY FORWARD SCATTERING AND TWO-BODY SCATTERING. Pinsky, Stephen (Univ. of Utah, Salt Lake City). Phys. Rev., D; 6: No. 3, 840-3(1 Aug 1972).

The concept of duality is generalized to three-body elastic scattering. The intermediate region where both a Regge and a resonance description exist is discussed, and through a comparison of the two processes information about elastic and quasielastic scattering is obtained. The dual-resonance model is considered as an example of this generalized duality. The theoretical results are applied to pp → pp, pp → pN′(1520), pp → pN′(1670), and pp → pΔ(1236), which are all shown to have a universal behavior. (auth)

49104 PION EXCHANGE AND THE COSMIC-RAY NUCLEON CASCADE. Bishari, Mordechai; Yesian, Harry J. (Univ. of California, Berkeley). Phys. Rev., D; 6: No. 3, 919-21(1 Aug 1972).

A model for $p + p \rightarrow n + X$ based on one-pion exchange is shown to compare satisfactorily with the propagation of cosmic-ray nucleons through the atmosphere. (auth)

Particle Invariance Principles and Symmetries

General

Refer also to abstracts 48946, 49010, 49156, 49198, and 49232.

49105 (LYCEN–7112) ON THE GENERALIZED EXCHANGE OPERATORS FOR SU(n). Partensky, A. (Lyon Univ. (France). Institut de Physique Nuclеaire). Feb 1972. 25p. Dep. NTIS (U. S. Sales Only).

The work of Biedenharn is used to redefine the k-particle generalized exchange operators (g.e.o.) and to study their properties. A straightforward but cumbersome calculation is used to derive the expression, in terms of the SU(n) Casimir operators of the 2, 3, or 4 particles g.e.o. acting on the A-particles states which extend over an irreductible representation of the SU(n). A striking and interesting result is that the eigenvalues of each of these g.e.o. do not depend on the n in SU(n) but only on the Young pattern associated with the irreducible representation considered. For a given g.e.o., the eigenvalues corresponding to two conjugate Young patterns are the same except for the sign which depends on the parity of the g.e.o. considered. (France)

49106 CAUSALITY AND THE SPONTANEOUS BREAKDOWN OF CONFORMAL SYMMETRY. Laue, H. (Univ. of Calgary, Alberta). Nuovo Cim.; 10B: No. 1, 283-90(11 Jul 1972).

A possible connection between the global transformation properties of the conformal group and spontaneous breaking of conformal symmetry is investigated. (auth)

49107 DIFFERENTIABLE, ANALYTIC, AND ENTIRE VECTORS IN GROUP REPRESENTATIONS. Nagel, B. pp 83-93 of Mathematical Problems in Theories of Particles and Fields. Goteborg; Chalmers Tekniska Hogskola (1971).

From Mathematical problems in theories of particles and fields conference; Goteborg, Sweden (7 Jun 1971). See CONF-710650; CTH-ITP–71-16.

Results concerning properties of differentiable, analytic, and entire vectors of representations of Lie groups (mainly unitary) are surveyed. (auth) (FHS) (Sweden)

49108 THEORY OF INONU–WIGNER CONTRACTION AND APPLICATIONS TO UNITARY SYMMETRY. Coodin, Perry. Toronto; Univ. of Toronto (1971). National Library of Canada, Ottawa.

Thesis.

Several definitions of Lie algebra contraction are introduced including those of Saletan and Inonu and Wigner. The physical interpretation of contraction is discussed in general, with particular attention to the contraction of Inonu and Wigner. Isomorphic contractions need not be physically equivalent, and the notion of a physical correspondence between the original and contracted algebras is introduced in this regard. The structure of Inonu–Wigner contraction is studied in detail and several abstract results are obtained. A number are of immediate physical importance, including the necessary and sufficient conditions that an Inonu–Wigner contraction be compact or solvable. The application of contraction to approximate symmetry of elementary particles is considered. All subalgebras of the Lie algebra SU(3) are determined and classified up to inner automorphism, and the Inonu–Wigner contractions of SU(3) are then discussed in the context of particle symmetries. A number of the abstract results on contraction find application here. Finally, the complexification A_2 of SU(3) is studied. Its subalgebras are determined and classified by methods which are to a considerable extent applicable to other complex simple Lie algebras. (Diss. Abstr. Int., B)

49109 LECTURES ON SYMMETRIES. Lopes, J. Leite. Documents on Modern Physics. New York; Gordon and Breach, Science Publishers, Inc. (1969). 179p.

An elementary survey of classical symmetries is given and covers symmetries in classical mechanics of systems of point particles, symmetries in classical linear field theory, and the problem of energy–momentum tensor conservation in the relativistic theory of gravitation. Also inversion operations in quantum field theory are treated including a review of the foundations of quantum field theory, space reflection and parity for Bose and Fermi fields, particle–antiparticle conjugation, Majorana neutral fields, parity of Majorana neutral fermions, time reversal, and strong reflection. (J.F.P.)

49110 FINITE TRANSFORMATIONS OF SU(3). Akyeampong, D. A.; Rashid, M. A. (International Centre for Theoretical Physics, Trieste, Italy). J. Math. Phys. (N. Y.); 13: No. 8, 1218-24(Aug 1972).

The finite transformations in an arbitrary irreducible representation of the SU(3) group are obtained by considering the reduced matrix elements of the operator $e^{-i\nu\lambda_4}$. The special case of $\nu = \frac{1}{2}\pi$ is also worked out and shown to be in agreement with earlier derivations. Symmetry properties and addition theorems for the resulting matrix elements are explicitly stated. As a useful application of the method, the finite transformations of the Weyl subgroup on the basis vectors of an arbitrary irreducible representation of SU(3) are also given. (auth)

Applications (Electromagnetic and Weak)

Refer also to abstracts 48893, 49020, 49021, and 49024.

49111 MAGNETIC MOMENTS OF BARYONS IN THE GENERALIZED UNITARY SYMMETRY. Danilyuk, B. V. Vestn. Mosk. Univ., Ser. III. Fiz. Astron.; 12: No. 6, 724-6(1971). (In Russian).

A theory was formulated to provide a generalization of an earlier proposed theory of strong interactions for baryons and mesons which yielded data on magnetic moments of hadrons. The results of the newer development may be used to calculate magnetic moments of hadrons and the ratios of coupling constants. (K.S.W.)

49112 CP VIOLATION, NEUTRAL CURRENTS, AND WEAK EQUIVALENCE. Fitch, Val L. (Princeton Univ., N. J.). AIP (Amer. Inst. Phys.) Conf. Proc.; No. 6, 127-50(1972).

From Conference on particle physics; Irvine, CA. (3 Dec 1971). See CONF-711220.

A review is given of CP violation, neutral currents, and the equivalence principle. The parameters for CP violation in the neutral K system decay are discussed including η_{+-}, η_{00}, the status of the Wu–Yang triangle, charge asymmetry, strangeness-changing neutral currents in $K^0_2 \to \mu^+ + \mu^-$ decay, and limits on the weak equivalence principle in general relativity from K^0 decay. (J.F.P.)

49113 CPT INVARIANCE OF CP-NONINVARIANT THEORY OF K^0 AND $\bar{K}^0$ MESONS AND PERMISSIBLE MASS DISTRIBUTIONS OF THE K_S AND K_L MESONS. Khalfin, L. A. JETP Lett. (USSR) (Engl. Transl.); 15: No. 9, 388-92(5 May 1972).

Translated from Zh. Eksp. Teor. Fiz., Pis'ma Red.; 15: No. 9, 548-52(5 May 1972).

It is shown that within the framework of the CP-noninvariance theory the CPT-invariance requirement forbids single-pole distributions of the K^0_1 and K^0_2 meson masses. It is noted that within the framework of the CP-invariance theory, on the other hand, a single-pole distribution of these masses is permissible. (J.F.P.)

49114 COSMOLOGICAL IMPLICATIONS OF THE MICROSCOPIC CP VIOLATION. Ne'eman, Yuval; Achiman, Yoav (Tel-Aviv Univ., Israel). pp 259-64 of Relativity and Gravitation. /Kuper, Charles G. (ed.). New York; Gordon and Breach, Science Publishers, Inc. (1971).

From Seminar on relativity and gravitation; Haifa, Israel (15 Jul 1969). See CONF-690713.

The conjecture linking together statistical and cosmological time arrows implies interpreting the contracting phase in an oscillating cosmological model as a time-inverted expansion. The Fitch–Cronin effect now requires a redefinition of what is matter and what is antimatter in this time-inverted picture. However, if CPT is also broken, then the T-violating effects yield a different set of laws altogether for such reactions. (auth)

49115 SOME ASPECTS OF (8,8) CHIRAL SYMMETRY BREAKING. Genz, H. (Univ., Karlsruhe, Ger.); Katz, J. Phys. Rev., D; 6: No. 3, 908-18(1 Aug 1972).

It is assumed that the chiral-symmetry-breaking Hamiltonian density transforms as part of the (8,8) representation of SU(3) ⊗ SU(3). A spectral-function sum rule for the model is then derived, and use is made of SU(3) assumptions to determine the symmetry-breaking parameter z. It is found that $z \approx -0.565$, in agreement with previous evaluations which made use of different techniques. The analogy to the $(\bar{3},3) \oplus (3,\bar{3})$ model of SU(3) ⊗ SU(3)-symmetry breaking is stressed. Other values of z for which the (8,8) model exhibits distinct qualitative features are also discussed. The soft-pion calculation of the K_{l3} form factors in the (8,8) model is presented. (auth)

Applications (Strong)

Refer also to abstracts 49056 and 49160.

49116 SPONTANEOUS BREAKINGS OF CHIRAL SYMMETRIES. II. MASS RELATIONS AND PARTICLE MIXINGS. Cicogna, G. (Univ., Pisa, Italy); Strocchi, F.; Vergara Caffarelli, R. Phys. Rev., D; 6: No. 1, 301-18(1 Jul 1972).

A detailed analysis of SU(3) × SU(3) symmetry breaking by a $(3, \bar{3}) + (\bar{3}, 3)$ linear term is given, with no reference to a Lagrangian model and by carefully taking into account the SU(3) noninvariance of the vacuum. Sum rules are derived and a detailed discussion of the κ mass and the $\eta-\eta'$ mixing angle is given. By carefully handling the delicate problem of approximations, no inconsistency is found with the experimental data, in contrast with results that have appeared in the literature. The over-all picture is instead in very good agreement with experiments, thus showing that SU(3) × SU(3) symmetry breaking is a very precise framework for discussion of elementary-particle symmetries. Corrections to SU(3) results, arising from the SU(3) noninvariance of the vacuum, are discussed. It is found that, in general, neglecting $\lambda_8 \equiv \langle 0|u_8|0\rangle$ is a dangerous approximation. In particular, the value of the $\eta-\eta'$ mixing angle is shown to depend very strongly on λ_8, a point which has not been realized in the literature. A generalized Gell-Mann–Okubo mass formula taking into account the SU(3) noninvariance of the vacuum is derived and it is found to be in extremely good agreement with experiment, thus showing that SU(3) × SU(3) symmetry breaking may be even more precise than SU(3) symmetry breaking. The high degree of accuracy of the sum rules resolves the ambiguity in the identification of the ninth pseudoscalar meson and provides a very precise determination of the $\eta-\eta'$ mixing angle. (auth)

49117 BROKEN ALGEBRA OF CURRENTS AND THE CABIBBO ANGLE. Oehme, R. (Univ. of Chicago). Phys. Lett.; 40B: No. 4, 491-4(24 Jul 1972).

Hadron currents are introduced which violate the chiral SU(3) × SU(3) algebra, but leave the subalgebra of SU(2) × SU(2) unchanged. The coefficient of the symmetry breaking current can be related to the Cabibbo angle and the meson mass splitting. Two models are considered which give explicit values for this angle. (auth)

49118 RELATION BETWEEN NONLINEAR AND LINEAR REALIZATIONS OF SU(3) x SU(3): THEORY AND APPLICATIONS. McDonald, A.; Rosen, S. P. (Purdue Univ., Lafayette, Ind.). Phys. Rev., D; 6: No. 2, 654-65(15 Jul 1972).

In an earlier paper the most general, nonlinear form was taken for the action $[K_a, \pi_b]$ of chiral operators upon an octet of pseudoscalar-meson fields, and functions z_α and $\bar{z}_\beta(\alpha, \beta = 0, 1, 2, \ldots, 8)$ were developed which span the $(3,\bar{3})$ and $(\bar{3},3)$ representations of chiral SU(3) symmetry. Here the nonlinear properties of z_α are used to show that the 3 × 3 matrix $(\Sigma_0^8 \lambda_\alpha z_\alpha)$ is proportional to a unitary, unimodular matrix $\exp(i\Sigma_1^8 \omega_k \lambda_k)$. It is then found that the matrix Λ which converts an arbitrary nonlinear field into a linear realization of SU(3) × SU(3) is a pure chiral transformation with ω_k as its parameters, $\Lambda = \exp(i\Sigma_1^8 \omega_k X_k)$. This result enables the equivalence of different approaches to the theory of nonlinear realizations to be demonstrated, and a model to be constructed for meson-baryon scattering. In the model, chiral symmetry is broken by a mass term which transforms as an admixture of singlet and octet members of the $(m,\bar{m})$ representation of SU(3) × SU(3). There are thirty parameters in the most general symmetry-breaking Lagrangian, but this number can be reduced to eight with reasonable assumptions. Unfortunately this is still too large a number for us to learn anything definitive about the manner of chiral symmetry breaking. (auth)

49119 SPONTANEOUS BREAKDOWN AND HADRONIC SYMMETRIES. Bardakci, K.; Halpern, M. B. (Univ. of California, Berkeley). Phys. Rev., D; 6: No. 2, 696-701 (15 Jul 1972).

Using the ideas of Higgs and Weinberg about spontaneous symmetry breakdown, possibly renormalizable models of low-spin hadrons, including massive non-Abelian vector mesons, are constructed. An intriguing new view of hadron symmetries and symmetry breaking emerges. (auth)

49120 SYMMETRIES AND RESONANCES (THEORETICAL). Lipkin, Harry J. (Argonne National Lab., Ill. National Accelerator Lab., Batavia, Ill. Weizmann Inst. of Science, Rehovoth, Israel). AIP (Amer. Inst. Phys.) Conf. Proc.; No. 6, 30-66(1972).

From Conference on particle physics; Irvine, CA. (3 Dec 1971). See CONF-711220.

In baryon phenomenology recent work by G. H. Trilling on SU(3) tests is mainly discussed. It is shown that SU(3) predictions relating cross sections can be greatly improved by the introduction of angular momentum barrier penetration coefficients, as is already routine when making SU(3) classifications of resonances. Under mesons $\pi\pi$ and $K\pi$ s-wave scattering is discussed. The recent work of Flatté et al. and of Protopopescu et al. explains s-wave $\pi\pi$ scattering in terms of two poles: ϵ at $\sqrt{s} = 600 \pm 70 - i(250 \pm 50)$ MeV on sheets II or IV, S* at $\sqrt{s} = 980 \pm 7 - i(38 \pm 7)$ MeV on sheet II. (auth)

49121 RESONANCES AND SYMMETRIES. Rosenfeld, Arthur H. (Univ. of California, Berkeley). AIP (Amer. Inst. Phys.) Conf. Proc.; No. 6, 1-29(1972).

From Conference on particle physics; Irvine, CA. (3 Dec 1971). See CONF-711220.

The state of the art for symmetries and resonances is summarized. The parton model, inclusive reactions, the quark model, resonance spectroscopy, and the new exotic particles are discussed. (J.F.P.)

49122 CYLINDRICAL WAVE SOLUTIONS OF GAUGE-INVARIANT GENERALIZATION EQUATIONS OF FIELD THEORIES WITH ASYMMETRIC FUNDAMENTAL TENSOR. Lal, K. B.; Singh, T. (Univ. of Gorakhpur, India). Tensor; 23: No. 2, 185-92(May 1972).

The gauge-invariant generalization equations of unified field theories with an asymmetric fundamental tensor are considered in a cylindrically symmetric space–time. The cylindrical wave solutions are discussed. (J.F.P.)

49123 ELECTROMAGNETIC SYSTEM OF A READING IN RELATIVISTIC ELECTRODYNAMICS OF NONHOMOGENEOUS MEDIA. Lebashev, A. E.; Nguyen Van Thuoa (Belorussian State Univ., Minsk). Vestsi Akad. Navuk BSSR, Ser. Fiz.-Mat. Navuk; No. 6, 62-5(1971). (In Russian).

Nonhomogeneous dielectrics and magnets in an electric field were examined, and a system called an electromagnetic system of reading was introduced. Space-time in a nonhomogeneous dielectric was studied as the basis for a laminated space. In each layer the metrics of a special theory of relativity existed. For establishing the connection of the layers, a coefficient of association with an absolute parallelism was introduced. A pondermotive force, acting on a nonhomogeneous dielectric in an electric field, and the Eucenvald–Wilson effects at the boundary of two media were investigated as examples. (tr-auth)

Field Theories

General

49124 EQUIVALENCE OF TWO EARLY UNIFIED FIELD THEORIES. Tupper, B. O. J. (Univ. of New Brunswick, Frederiction). Tensor; 23: No. 2, 169-73(May 1972).

It is shown that although the unified field theories of Einstein and Levi–Civita are not identical they are equivalent for certain choices of the ennuple vectors. (J.F.P.)

49125 STATIC ELECTROMAGNETIC FIELDS IN GENERAL RELATIVITY. Datta, Bidyut Kumar (Surendra Nath Coll., Calcutta). pp 111-21 of Relativity and Gravitation. /Kuper, Charles G. (ed.). New York; Gordon and Breach, Science Publishers, Inc. (1971).

From Seminar on relativity and gravitation; Haifa, Israel (15 Jul 1969). See CONF-690713.

The equations of Rainich's "already-unified field theory" are studied in the case of static electromagnetic fields, and electromagnetic fields are obtained for two space–time metrics each of which admits a group G_4 of automorphisms. It turns out that in one case there exists an electromagnetic field for which there is a uniform charge along the axis of density, while in the other field there is a flow of current along the axial direction which produces a magnetic field in the angular direction. (auth)

49126 MATHEMATICAL MODELS FOR THE EVALUATION OF ELECTRIC AND MAGNETIC FIELDS. Tozoni, O. V. New York; Gordon and Breach, Science Publishers, Inc. (1969). 335p.

This book deals with the simulation of magnetic fields by mathematical models and their solution using computers. Algorithms are constructed for various field calculation problems. Errors introduced by the assumption of a bounded field are considered, and methods for minimizing such errors are given. (D.L.C.)

Quantum Field Theory

Refer also to abstracts 48940, 48954, 48973, 49025, and 49109.

49127 (JINR–E2-6566) STOCHASTIC SPACES. Blokhintsev, D. I. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics). 1972. 44p. Dep. NTIS (U. S. Sales Only).

A sketch of theory of stochastic spaces is presented. The definition of the stochastic space is given; some special cases are considered: nonlinear fields and stochastic spaces; stochastic spaces resulting from approximate solving of the field equations in a random medium; stochastic spaces due to the turbulent gravitation or due to the quantum fluctuations of the gravitation. (auth)

49128 (JINR–P2-6445) APPROXIMATE FUNCTIONAL INTEGRATION METHODS AND CONCEPTION OF STRAIGHT-LINE PATHS AT HIGH ENERGIES. Kuleshov, S. P.; Matveev, V. A.; Sisakyan, A. N.; Smondyrev, M. A. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics). 1972. 16p. (In Russian). Dep. NTIS (U. S. Sales Only).

A number of approximate methods of calculation of the functional integrals which can be used to find the Green functions and the scattering amplitudes in quantum field theory are formulated. It is shown that in the investigation of particle scattering at high energies and fixed momentum transfers these methods are the different versions of the straight-line path approximation. (auth)

49129 (JINR–P2-6496) SOLUTION OF QUASIPOTENTIAL TYPE EQUATION BY UNDETERMINED COEFFICIENT METHOD. Atanasov, A. A.; Garsevanishvili, V. R. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics). 1972. 12p. (In Russian). Dep. NTIS (U. S. Sales Only).

The undetermined coefficient method is applied to the solution of the quasipotential type equation in case when the kernel of the resolvent operator is bounded. In a particular case a possibility is shown to represent the solution as the Pade-fraction. (auth)

49130 (NP–19336) MORE ABOUT LORENTZ TRANSFORMATIONS AND TACHYONS: ANSWER TO THE COMMENTS BY RAMACHANDRAN, TAGARE, AND KOLASKAR. Recami, E.; Mignani, R. (Catania Univ. (Italy). Istituto di Fisica Teorica. Istituto Nazionale di Fisica Nucleare, Catania (Italy)). 1971. 17p. Dep. NTIS (U. S. Sales Only).

Lorentz transformations, in four dimensions, are generalized for relative velocities greater than the velocity of light. Among their properties: the generalized Lorentz transformations (GLT) form a group, G, together with the usual ones (LT); are complex, and it is $GLT = i \cdot LT$; are "pseudo-unitary;" transform bradyons into tachyons and vice-versa. The GLT are compatible with superluminal frames being physical. Tachyons have a real rest-mass, while the validity of their usually-assumed kinematics is preserved. The concept of general covariance ("G-covariance"), with respect to the whole group G, is illustrated by one case. The essential observation is that, when passing from a subluminal to a superluminal frame, the pseudo-Euclidean metric happens to invert: This explains why imaginary quantities were always met with, when previous authors approached the problem. Besides, the possibilities for superluminal frames to be physical or unphysical are discussed. At last, the behavior of tachyons with respect to the exchange of photons is analyzed. (auth)

49131 (NP–19370) INFRARED DIVERGENCES AND ADIABATIC SWITCHING. FOURTH ORDER VACUUM POLARIZATION. Barbieri, R. (Scuola Normale Superiore, Pisa (Italy)); Remiddi, E. (Bonn Univ. (West Germany). Physikalisches Institut). May 1972. 24p. Dep. NTIS (U. S. Sales Only).

It is shown in an explicit case that quantum electrodynamics quantities can be defined without reference to massive photon theory. The renormalized expression for the fourth order vacuum polarization amplitude is written. The adiabatic switching formalism suggested a new way to deal with the infrared divergent Feynman graphs. (J.F.P.)

49132 (ORO–3992-100) HEISENBERG EQUATIONS OF MOTION FOR THE CHARGED SPIN 3/2 FIELD. Mainland, G. B.; Sudarshan, E. C. G. (Texas Univ., Austin. Center for Particle Theory). 20p. (CPT–154). Dep. NTIS.

The charged spin-$^3/_2$ field is quantized in the presence of a minimal external electromagnetic interaction, and it is shown that contrary to recent claims, the Lagrange and Heisenberg equations of motion for the quantized fields are the same. For dynamical systems with constraints depending upon external fields, the explicit dependence of the dynamical variables upon these external fields must be taken into account. (auth)

49133 (SLAC-PUB–1010) ELECTRODYNAMICS AT VERY LOW AND VERY HIGH ENERGIES. Brodsky, Stanley J. (Stanford Linear Accelerator Center, Calif. Sussex Univ., Brighton (England). School of Mathematical and Physical Sciences). [nd]. 110p. Dep. NTIS.

Lectures are given on the theoretical treatment of electromagnetic interactions especially the Compton amplitude from very low to very high energies. Also the high energy aspects of field theoretic electrodynamics and nucleon problems especially Compton scattering and inelastic electron scattering are treated. The free electron vertex, the hydrogen and relativistic atoms, the atom in an external field, the Lamb shift, eikonal techniques in high energy quantum electrodynamics, inelastic electron scattering in field theory, and the parton model in field theory are covered. (J.F.P.)

49134 SECOND-ORDER SCATTERING WITH SINGLE COUPLING FOR A UNIFIED FIELD IN SCALAR ELECTRODYNAMICS. Kuvshinov, V. I.; Fedorov, F. I. (Inst. of Physics, Minsk). Vestsi Akad. Navuk BSSR, Ser. Fiz.-Mat. Navuk; No. 6, 53-61 (1971). (In Russian).

The second quantization of a unified field ψ, which described simultaneously the scalar particles, antiparticle, and photon, is presented. On the basis of Lagrange interaction $L' = ie/3!\ P\psi\psi\psi$ (where $P =$ the symmetrical matrix for all indices) of scalar electrodynamics, an equation is found for the amplitude of second-order scattering, including a description of some group processes and having crossing-symmetrical momentum fraction. (tr-auth)

49135 VVEDENIE V KVANTOVUYU TEORIYU POLYA. (Introduction to Quantum Field Theory). Kushnirenko, A. N. Moscow; Izdatel'stvo Vysshaya Shkola (1971). 304p.

After a general treatment of complex fields, isolated (free) fields, interacting fields, examples of calculations of interaction processes between electrons and photons are examined: spontaneous photon emission, Compton scattering, pair production, and pair annihilation. Attention is focused on the elimination of divergence from an S-matrix by renormalization of mass and charge. Feynman's graphs, the Ward identity, Green's function, and the parametric representation of distribution functions are set forth as part of the discussion of the latter topic. The relation of average and characteristic values of physical quantities with a scattering matrix and their application is treated. (K.S.W.)

49136 COHERENCE, CORRELATION, AND QUANTUM FIELD THEORY. Klauder, John R. (Bell Telephone Labs., Inc., Murray Hill, N. J.). pp 201-302 of Elementary Particle Physics and Scattering Theory. Vol. 2. /Chretien, M. (ed.). New York; Gordon and Breach, Science Publishers, Inc. (1970).

In these lectures the appropriate quantum framework is developed in sufficient generality in order to discuss selected topics in quantum optics and to develop Euclidean-invariant model field theories having scattering and production. The general features of phase-space continuous representations, quantum coherence theory, and aspects of the canonical commutation relations, the weak correspondence principle and field theoretic models are covered. (J.F.P.)

49137 ELECTROMAGNETIC AND WEAK MASSES. Weinberg, Steven (Massachusetts Inst. of Tech., Cambridge). Phys. Rev. Lett.; 29: No. 6, 388-92(7 Aug 1972).

In theories with spontaneously broken gauge symmetries, various masses or mass differences may vanish in zeroth order as a consequence of the representation content of the fields appearing in the Lagrangian. These masses or mass differences can then be calculated as finite higher-order effects. The mechanism for cancelation of divergences in second-order fermion masses is described explicitly. The weak interactions play an essential role in canceling infinities in electromagnetic masses. (auth)

49138 AROUND-THE-WORLD ATOMIC CLOCKS: PREDICTED RELATIVISTIC TIME GAINS. Hafele, J. C. (Washington Univ., St. Louis); Keating, Richard E. Science; 177: No. 4044, 166-8 (14 Jul 1972).

During October 1971, four cesium beam atomic clocks were flown on regularly scheduled commercial jet flights around the world twice, once eastward and once westward, to test Einstein's theory of relativity with macroscopic clocks. From the actual flight paths of each trip, the theory predicts that the flying clocks, compared with reference clocks at the U.S. Naval Observatory, should have lost 40 ± 23 nanoseconds during the eastward trip, and should have gained 275 ± 21 nanoseconds during the westward trip. (auth)

49139 EQUILIBRIUM IN SPECIAL RELATIVITY. Aranoff, S. (Univ. of the Negev, Beer Sheva, Israel). Nuovo Cim.; 10B: No. 1, 155-71(11 Jul 1972).

It is shown that there are no energy currents perpendicular to the forces on an object. Many reasons for the erroneous nature of the von Laue energy current are given. This energy current is of no help in formulating equilibrium conditions in the conventional synchronous formulation, where additional ad hoc momenta due to the non-conservation of simultaneity have to be added. Equilibrium maintained by continuous time-dependent forces cannot be defined by the simultaneous vanishing of the forces. On the other hand, in the asynchronous formulation of Cavalleri and Salgarelli, equilibrium is given in terms of only the forces and torques. The relevant torque tensor $T_{\mu\nu}$ is defined. This tensor is the sum of quantities evaluated at different times, corresponding to the Lorentz transformation of simultaneous measurements in the proper inertial frame S. Consequently, if $T_{\mu\nu} = 0$, then $T'_{\mu\nu}$, the torque in another inertial frame S′, also vanishes. Numerous objections are fully discussed. It is shown that there is no paradox in the Trouton–Noble experiment. Finally, it is shown why it is impossible to formulate the usual Hamiltonian for interacting particles in special relativity in terms of the coordinate time t; instead, one must use individual proper times τ. (auth)

49140 AROUND-THE-WORLD ATOMIC CLOCKS: OBSERVED RELATIVISTIC TIME GAINS. Hafele, J. C. (Washington Univ., St. Louis); Keating, Richard E. Science; 177: No. 4044, 168-70 (14 Jul 1972).

Four cesium-beam clocks flown around the world on commercial jet flights during October 1971, once eastward and once westward, recorded directionally dependent time differences which are in good agreement with predictions of conventional relativity theory. Relative to the atomic time scale of the U. S. Navy Observatory, the flying clocks lost 59 ± 10 nanoseconds during the eastward trip and gained 273 ± 7 nanoseconds during the westward trip, where the errors are the corresponding standard deviations. These results provide an unambiguous empirical resolution of the famous clock "paradox" with macroscopic clocks. (auth)

49141 RENORMALIZATION OF A SCALAR FIELD THEORY IN STRONG COUPLING. Wilson, Kenneth G. (Cornell Univ., Ithaca, N. Y.). Phys. Rev., D; 6: No. 2, 419-26(15 Jul 1972).

The renormalization problem is solved, qualitatively, for the $\lambda_0\phi^6$ interaction of a scalar field $\phi(x)$ in two space and one time dimensions. The theory is found to be finite after mass renormalization, although perturbation theory predicts there should be ϕ^4 and ϕ^6 counterterms also. The renormalized theory is an interacting theory; it is scale-invariant at short distances. The field ϕ has canonical dimension $^1/_2$ in mass units (but this dimension may change in a more quantitative analysis) while the renormalized form of ϕ^2 has a noncanonical dimension, about 1.36. The cutoff dependence of the theory is computed by evaluating the Feynman path integral qualitatively. The analysis reduces the problem to a recursion formula for a function of one variable which acts as a representation of the renormalization group. The method of analysis is applicable to any scalar field theory. (auth)

49142 TACHYON COMMUTATOR AND INVARIANCE. Murphy, J. E. (Louisiana State Univ., New Orleans). Phys. Rev., D; 6: No. 2, 426-8(15 Jul 1972).

Using the Klein–Gordon equation and relativistic invariance, the commutator and anticommutator for free tachyon fields are calculated. The form of the spectral representation of the vacuum expectation value of the commutator is exhibited for interacting tachyon fields. (auth)

49143 GAUGE THEORIES WITHOUT ANOMALIES. Georgi, Howard; Glashow, Sheldon L. (Harvard Univ., Cambridge, Mass.). Phys. Rev., D; 6: No. 2, 429-31(15 Jul 1972).

Theories with spontaneously broken gauge symmetry but without triangle anomalies can yield renormalizable models of weak and electromagnetic interactions. The class of anomaly-free gauge theories is identified and discussed. (auth)

49144 EFFECT OF ANOMALIES ON QUASI-RENORMALIZABLE THEORIES. Gross, David J. (Princeton Univ., N. J.); Jackiw, R. Phys. Rev., D; 6: No. 2, 477-92(15 Jul 1972).

Apparently nonrenormalizable field theories, such as the new models for weak interactions, can become renormalizable when gauge invariance of the second kind is present. However, the anomaly associated with the axial-vector current may destroy this gauge invariance in perturbation theory, even though it is present in the Lagrangian. When this happens the theory remains nonrenormalizable. Nevertheless it is possible, by enlarging the theory, to remove the anomaly at the expense of introducing additional fermion fields, which correspond to as-yet-unobserved particles. (auth)

49145 QUASISECULAR RENORMALIZATION OF THE ϕ^4 MODEL OF QUANTUM FIELD THEORY. Stanley, Oe. Aks; Sienicki, James; Varga, B. B. (Univ. of Illinois, Chicago). Phys. Rev., D; 6: No. 2, 520-8(15 Jul 1972).

The Heisenberg equations of the ϕ^4 model of quantum field theory in one space dimension are analyzed by a modified perturbation method. The modification focuses on terms with vanishing and small energy denominators. These terms give rise to operator-valued frequency (mass) renormalization and amplitude (wave-function) renormalization. These renormalization effects remain present in the limit of an infinite system because the number of terms with small energy denominators becomes infinite. (auth)

49146 QUASISECULAR CLOTHING TRANSFORMATION FOR THE phi^4 MODEL OF QUANTUM FIELD THEORY. Varga, B. B.; Stanley, Oe. Aks (Univ. of Illinois, Chicago). Phys. Rev., D; 6: No. 2, 529-35(15 Jul 1972).

The first-order renormalized Heisenberg field for the ϕ^4 model of quantum field theory, calculated by the quasisecular perturbation method, is used to construct a clothing transformation. The clothing transformation gives the Fourier amplitude of the renormalized field from that of the bare field, except for the quasi-secular terms. The properties of the clothing transformation are examined in the cases of one, two, and three space dimensions. The connection with the strange representations of the canonical commutation relations is discussed. (auth)

49147 EXACT SOLUTIONS OF THE $\lambda\phi^4$ THEORY. Castell, L. (Max Planck-Institut zur Erforschung der Lebensbedingungen der Wissenschaftlich-Technischen Welt, Starnberg, Ger.). Phys. Rev., D; 6: No. 2, 536-8(15 Jul 1972).

Infinitely many sets of classical solutions of the field equation $\Box\varphi - \lambda\varphi^*\varphi\varphi = 0$ are given. Each set forms a nonlinear realization of the invariance group $SO_0(4,2)$ of the field equation. The problem of scattering is discussed. (auth)

49148 ASYMPTOTIC EXPANSIONS AND NONLINEAR FIELD THEORIES. Graffi, S. (New York Univ., N. Y.); Grecchi, V. Phys. Rev., D; 6: No. 2, 493-500(15 Jul 1972).

The Efimov–Fradkin method in nonlinear field theories, in the context of a simple rational function Lagrangian, is analyzed in the light of the Carleman uniqueness theorem for asymptotic expansion. It is proven that the Carleman theorem allows the elimination of the ambiguities related to the formal summation of the perturbation expansion in the minor coupling constant. This result however implies that the two-point Green's function to second order in the major coupling constant does not have the correct analyticity properties as required by unitarity. These results are easily generalized to other classes of nonlinear theories. (auth)

49149 FEYNMAN RULES FOR MASSLESS YANG–MILLS FIELD INTERACTING WITH NUCLEONS. Sidhu, Deepinder P. (State Univ. of New York, Stony Brook). Phys. Rev., D; 6: No. 2, 565–80(15 Jul 1972).

Feynman rules for the massless Yang–Mills field interacting with nucleons are derived using the well-known method of canonical quantization. In the radiation gauge for the $\vec{b}_\mu$ field, i.e., $\partial_i \vec{b}_i = 0$, the interaction Hamiltonian is an infinite series of noncovariant terms containing the $\vec{b}_\mu$ field and the ψ field thus giving an infinity of noncovariant vertices. It is shown that in spite of a seemingly infinite sequence of primary diagrams, it is possible to describe all the diagrams to any order by a set of noncovariant Feynman rules involving three propagators S_F, $D_{\mu\nu}$, and $F_{\mu\nu}$ and three vertices Γ^a_μ, $\Gamma^{abc}_{\mu\nu\lambda}$, and $\Gamma^{abcd}_{\mu\nu\lambda\sigma}$. The same set of noncovariant rules holds for diagrams with any number of loops provided that a loop with all $F_{\mu\nu}$-type propagators is multiplied by a weight factor $(1 - \frac{1}{2}^{n-1})$; all other loops have coefficients given by the symmetry number. It is proved that tree diagrams can be covariantized to any order thus giving a simple covariant set of Feynman rules to describe them to any order. Similarly the one loop to order g^2 can also be made covariant. Only the closed $\vec{b}_\mu$ field loops result in an extra scalar loop with weight (–2) relative to the vector loop on covariantization. (auth)

49150 HELICITY POLES AND THE TRIPLE-REGGE VERTEX. Jones, C. Edward; Low, F. E.; Young, J. E. (Massachusetts Inst. of Tech., Cambridge). Phys. Rev., D; 6: No. 2, 640–4 (15 Jul 1972).

The location of helicity poles in terms of Regge poles is determined by an examination of Misheloff's triple-Regge expansion in a special limiting case. For this case, the presence of two comparable asymptotic terms are identified on general grounds. In one term the helicity pole is at α_1; in the other it is at $\alpha_2 + \alpha_3$ where α_1, α_2, and α_3 are the three trajectories occurring in the Misheloff formulation. (auth)

49151 SCALE INVARIANT WILSON OPERATOR EXPANSION AND THE GENERALIZATION OF BJOERKEN FORMULA TO NONINTEGER ASYMPTOTIC POWERS. Lukierski, J. pp 51–67 of Mathematical Problems in Theories of Particles and Fields. Goteborg; Chalmers Tekniska Hogskola (1971).

From Mathematical problems in theories of particles and fields conference; Goteborg, Sweden (7 Jun 1971). See CONF-710650; CTH-ITP–71-16.

The asymptotic distribution-valued expansion at $x_0 = 0$ of the commutator function $\langle p|[J_A(x), J_B(0)]|p'\rangle$ is studied. It is shown that in the Wightman framework the equal time behavior is described by a finite number of one-dimensional tempered distributions. Further the scale-invariant expansions and particularly Wilson operator product expansion are considered as special cases. The generalization of Björken asymptotic expansion to the case when noninteger powers of $1/q_0$ are present is given. (auth) (Sweden)

49152 RESONANCES AS ELEMENTARY OBJECTS AND THE STATISTICS OF THEIR DECAY PRODUCTS. Lukierski, J.; Turko, L. pp 67–80 of Mathematical Problems in Theories of Particles and Fields. Goteborg; Chalmers Tekniska Hogskola (1971).

From Mathematical problems in theories of particles and fields conference; Goteborg, Sweden (7 Jun 1971). See CONF-710650; CTH-ITP–71-16.

The consistency of a field theory introducing elementary unstable resonances with the Haag–Ruelle theory of asymptotic states is discussed. Asymptotically free and kinematically independent resonances are expressed in terms of their stable decay products, which leads to a new kind of statistics called the resonance statistics. The properties of these new statistics, particularly the problem of crossing relations, are briefly discussed. (auth) (Sweden)

49153 PROBLEM OF RENORMALIZATION IN THE THEORY OF A RELATIVISTIC FERMI-SYSTEM IN AN EXTERNAL FIELD. Braun, M. A.; Sibirkina, T. N. (Leningrad State Univ.). Teor. Mat. Fiz.; 12: No. 1, 48–55(Jul 1972). (In Russian).

Renormalization is considered in the theory of a relativistic Fermi-system in an external field. The connection between the renormalized bare and physical external fields is obtained. The expression for the ground-state energy of a system in terms of renormalized quantities is found. (auth)

49154 AUTOMODELING ASYMPTOTICS IN QUANTUM FIELD THEORY. I. Bogolyubov, N. N.; Vladimirov, V. S.; Tavkhelidze, A. N. (Inst. of Mathematics, Moscow. Joint Inst. for Nuclear Research, Dubna, USSR). Teor. Mat. Fiz.; 12: No. 1, 3–17(Jul 1972). (In Russian).

In the framework of general principles of the local quantum field theory a method is developed which makes it possible to study the deeply inelastic electron nucleon scattering. The explanation of the automodeling behavior of form factors observed in the experiments is given. (auth)

49155 IMPOSSIBILITY OF FREE TACHYONS. Bers, A.; Fox, R.; Kuper, C. G.; Lipson, S. G. Technion–Israel Inst. of Tech., Haifa). pp 41–6 of Relativity and Gravitation. /Kuper, Charles G. (ed.). New York; Gordon and Breach, Science Publishers, Inc. (1971).

From Seminar on relativity and gravitation; Haifa, Israel (15 Jul 1969). See CONF-690713.

Despite the possibility of superluminal group velocities appearing in a Lorentz-invariant theory, it is shown that no Lorentz-invariant wave equation can be used for superluminal signal propagation. Causality is therefore not violated. However the Green function for imaginary-mass Klein–Gordon waves exhibits an absolute instability. Tachyons are excluded not by demanding causality, but by demanding that the tachyon vacuum be stable against fluctuations. (auth)

49156 APPLICATIONS OF SU(2) TECHNIQUE IN GENERAL RELATIVITY. Carmeli, Moshe (Aerospace Research Labs., Wright-Patterson AFB, Ohio). pp 69–76 of Relativity and Gravitation. /Kuper, Charles G. (ed.). New York; Gordon and Breach, Science Publishers, Inc. (1971).

From Seminar on relativity and gravitation; Haifa, Israel (15 Jul 1969). See CONF-690713.

Spin weighted field functions employed in discussing gravitational radiation problems in general relativity are considered as functions over the group SU(2). As a result the Newman–Penrose formalism for obtaining exact gravitationally-conserved quantities is given a group-theoretic interpretation. (auth)

49157 ENERGY TENSOR OF A PERFECT FLUID. Cattaneo, C. (Univ., Rome). pp 77–80 of Relativity and Gravitation. /Kuper, Charles G. (ed.). New York; Gordon and Breach, Science Publishers, Inc. (1971).

From Seminar on relativity and gravitation; Haifa, Israel (15 Jul 1969). See CONF-690713.

It is shown that sound waves propagate through a nonviscous relativistic fluid with a velocity never exceeding that of light from the form of the energy–momentum tensor without the need of a further ad hoc hypothesis. (J.F.P.)

49158 NEW EXPERIMENTAL TESTS OF RELATIVITY. Fox, R.; Shamir, J. (Technion–Israel Inst. of Tech., Haifa). pp 163–71 of Relativity and Gravitation. /Kuper, Charles G. (ed.). New York; Gordon and Breach, Science Publishers, Inc. (1971).

From Seminar on relativity and gravitation; Haifa, Israel (15 Jul 1969). See CONF-690713.

It is shown that the Michelson–Morley experiment performed in a solid transparent medium is capable of distinguishing between special relativity and rival theories based on a preferred frame of reference and physical Lorentz contractions. This experiment was performed and its negative result enhances the experimental basis of special relativity. An experiment suggested by Yilmaz some time ago to test the equivalence principle for photons is also described. Theoretically, a violation of the equivalence principle could lead to an anisotropy in the velocity of light with respect to the sun of the order of $\Delta c/c \approx 9 \times 10^{-9}$. An experimental upper limit of 3×10^{-11} was found. (auth)

49159 GAUGE INVARIANCE AND OBSERVER DEPENDENCE. Goldberg, Irwin (Drexel Inst. of Tech., Philadelphia). pp 177–88 of Relativity and Gravitation. /Kuper, Charles G. (ed.). New York; Gordon and Breach, Science Publishers, Inc. (1971).

From Seminar on relativity and gravitation; Haifa, Israel (15 Jul 1969). See CONF-690713.

A modification of the Bergmann quantization procedure is applied to the relation among gauge invariance, manifest covariance, and observer dependence in electrodynamics. (J.F.P.)

49160 SYMMETRY BREAKING IN A FIELD THEORY OF CURRENTS. Le Monnier de Gouville, Christian. Milwaukee; Univ. of Wisconsin (1972). 123p. University Microfilms Order No. 72-18,754.

Thesis.

A field theory of currents is a relativistic quantum theory in which the basic Heisenberg fields are called currents. The matrix elements ${}^{in}\langle\alpha \mid \text{current} \mid \beta\rangle^{out}$ are in principle directly measurable through electromagnetic, weak and gravitational interactions. The essential purpose of a field theory of currents is to describe strong interactions which cannot be treated theoretically on the same footing as weak interactions. The choice of the basic currents is suggested by the existence of the approximate internal symmetries displayed by strong interactions. In the case of interest where strong interactions exhibit an approximate chiral SU(n) ⊗ SU(n) symmetry (n = 2, 3) the set of basic currents consists of $n^2 - 1$ vector currents $V_\mu^i(x)$, and $n^2 - 1$ axial vector currents $A_\mu^i(x)$, which are assumed to form a complete set of operators. The equal time commutation relations among the components of the currents are postulated. The completeness of the basic set of currents permits the construction of the energy momentum tensor as a function of the basic currents. From the form of the energy momentum tensor, which is assumed to satisfy the Schwinger condition, and the equal time commutation relations among the currents, the Heisenberg equations of motion for the basic currents can be derived. Furthermore the generators of the Poincaré group constructed from the energy momentum tensor allow one to construct the Poincaré algebra and to check the relativistic covariance of the theory. In this line of thought, the main features of the field theory of currents proposed by Sugawara are reviewed in detail. The Heisenberg equations of motion and the unitary singlet form of the energy momentum tensor, which are both derived from Sugawara's assumption, imply that the underlying chiral SU(n) ⊗ SU(n) symmetry of the theory is exact. Since an exact symmetry is not physically acceptable, the Sugawara theory is modified by adding, to the original set of vector and axial vector currents, a new set of fields which consists of the divergences of the nonconserved vector and axial vector currents. These divergences are interpreted as interpolating fields of physical particles and a generalized P.C.V.C.–P.C.A.C. assumption can be made. Furthermore, the energy momentum tensor is assumed to be the sum of the invariant Sugawara energy momentum tensor and a symmetry breaking term of the form $\delta_{\mu\nu}\phi(x)$. With the help of a few additional assumptions, it turns out that the nonzero divergences of the vector and axial vector currents form a nonlinear realization of the underlying SU(n) ⊗ SU(n) symmetry. Then, a general formalism is established giving a link between the functional form of the symmetry breaking term ϕ and the nonlinear realization of the symmetry. Several particular cases where the underlying symmetry is that of SU(2), SU(3) and SU(2) ⊗ SU(2) are respectively investigated. In all these cases it appears that the relation between the nonlinear realization and the functional form of the symmetry breaking is one to one. Furthermore, if the exotic commutators of the theory are assumed to vanish, both the nonlinear realization and the symmetry breaking are uniquely determined. In particular, when the underlying symmetry group is SU(2) ⊗ SU(2) the vanishing of the exotic commutators leads in a unique way to the nonlinear realization displayed by the σ-model. (Diss. Abstr. Int., B)

49161 RELATIVISTIC QUANTUM-MECHANICAL PROBLEM OF THE TWO-BODY SYSTEM. Tam, Kwong-chuen. Norman, Okla.; Univ. of Oklahoma (1972). 99p. University Microfilms Order No. 72-19,754.

Thesis.

A wave equation for two particles of arbitrary spin is derived using the Bethe–Salpeter integral equation with an arbitrary instantaneous interaction. The equation is rederived using a semi field-theoretic approach. This wave equation is purely a quantum-mechanical one. It contains the sum of Hamiltonians for the two particles and has the same form as the Breit equation for two spin-½ particles. Again applying the B-S integral equations with arbitrary instantaneous interaction to Klein–Gordon particles, one can show the connections between the quasipotential two-particle wave equations, the Bogolubov equation and the B-S equation. The wave equation for two spin-0 particles in Hamiltonian form is considered. The equation is simplified and solutions are obtained for square well and Coulomb potentials. The equation for a system of two spin-½ particles is also considered. This spinor equation is reduced to its simplest form and triplet and singlet state solutions are obtained for some potentials. A wave equation for two spin-1 particles is obtained starting from Weinberg's single spin-1 particle wave equation. This equation can be reduced to four second-order tensor equations. Further reduction of these equations to two equations is possible for the simplest state, the scalar–scalar state. For square well, these equations are further simplified. (Diss. Abstr. Int., B)

49162 HIGH-ENERGY TESTS OF QUANTUM ELECTRODYNAMICS AND WEAK INTERACTIONS. 1. PRODUCTION CROSS SECTIONS FOR LEE–WICK MASSIVE ELECTROMAGNETIC BOSONS AND FOR SPIN-0 AND SPIN-1 W-BOSONS AT HIGH ENERGIES. 2. KINEMATIC DISTRIBUTIONS FOR ELECTRON PAIR PRODUCTION BY MUONS. Linsker, Ralph. New York; Columbia Univ. (1972). 110p. University Microfilms Order No. 72-20,052.

Thesis.

The total cross section is calculated for the resonant process $l^\pm + Z \rightarrow l^\pm + Z' + B^0 \rightarrow l^\pm + Z' +$ (hadrons or leptons), where l = μ or e, and B^0 is the hypothetical massive spin-1 boson of electromagnetic interactions, proposed by Lee and Wick. Several (Z,Z′) cases have been studied, corresponding to elastic scattering off protons and neutrons (with and without an exclusion principle), coherent scattering off spin-0 nuclei, and inelastic scattering off protons (in which case Z′ denotes a nucleon resonance or hadronic system in the continuum). Detailed structure function data are used to improve the accuracy of the inelastic scattering calculation. At a beam energy of 200 to 300 GeV, the cross section exceeds 10^{-36} cm^2, provided the B^0 mass is not much greater than 10 GeV. Details of the calculations are given with results corresponding to NAL and higher energies. The cross section is also computed for the resonant process $\bar{\nu}_1(\nu_1) + Z \rightarrow l^\pm + Z' + W_0^\mp \rightarrow l^\pm + Z' +$ (hadrons or leptons) and for the extensively studied semiweak process $\bar{\nu}_1(\nu_1) + Z \rightarrow l^\pm + Z' + W_1$, where $W_{0,1}^\mp$ are the scalar and vector weak intermediate bosons. The cross section for $W_0^\pm$ production with l = μ is found to be at least an order of magnitude smaller than that for $W_1^\pm$, in nearly all regions of interest. The $W_0^\pm$ production cross section for inelastic scattering off protons is comparable to that for elastic scattering in the regions of interest; whereas in the B^0 and $W_1^\pm$ cases, the main contribution to the total cross section for production off protons is elastic. Cross sections and kinematic distributions for the trident production process $\mu^\pm + Z \rightarrow \mu^\pm + e^- + e^+ + Z$ (with Z = p and Fe) are given for beam energies of 100 to 300 GeV at fixed (e^-e^+) masses from 5 to 15 GeV. This process is interesting as a test of quantum electrodynamics at high energies, and in particular as a test of the form of the photon propagator at large timelike (four-momentum)^2. For this purpose, it is desirable to impose kinematic cuts that favor those Bethe–Heitler graphs which contain a timelike photon propagator. It is found that there are substantial differences between the kinematic distributions for the full Bethe–Heitler matrix element (which involves four graphs) and the distributions for the two timelike-photon graphs alone; these differences can be exploited in the selection of appropriate kinematic cuts. The competing virtual Compton process (for Z = p) was estimated on the basis of a simple model; its cross section is at least two orders of magnitude smaller than the Bethe–Heitler cross sections of interest, at the energies and (e^-e^+) masses considered. (Diss. Abstr. Int., B)

49163 FERMION–FERMION INTERACTION IN CONSTRUCTIVE QUANTUM FIELD THEORY. Manoukian, Edward Berge. Toronto; Univ. of Toronto (1971). National Library of Canada, Ottawa.

Thesis.

A cut-off field theory is studied describing the interaction of two distinguishable fermions in the Hamiltonian formalism. It is shown that the cut-off Hamiltonian is a self-adjoint operator in Fock space and its spectrum is bounded from below by the energy of the ground-state which is strictly negative. Without a space cut-off, it is proven that the lower bound of the Hamiltonian is minus infinity. The existence and uniqueness of the vacuum-state vector of the cut-off Hamiltonian is proven for a sufficiently small coupling constant, and then by a different method its existence is proven but not its uniqueness for any coupling constant. Using in the process the self-adjointness of the cut-off Hamiltonian the interacting fields are constructed and it is proven that they satisfy the usual nonlinear field equations in the sense of distributions. From the existence of a vacuum-state vector, the Wightman distributions are constructed and their equations of motion derived. It is shown that although the cut-off Hamiltonian does not necessarily exist as an operator in Fock space in the infinite volume limit, the smeared fields do exist and define bounded operators. The existence of the Wightman functions as tempered distributions in the infinite volume limit is then proved. The removal of the ultraviolet cut-off by Friedrichs' perturbation techniques is discussed and the difficulty in defining a Hamiltonian in the limit is pointed out. The nonrenormalizability of the model by the conventional Dyson–Salam procedure is well known. Scattering theory is studied. Wave operators are defined in terms of asymptotic creation and annihilation operators and the eigenvectors of the total Hamiltonian. The scattering states are in some closed subspaces of the Fock space equipped with a renormalized inner product. This renormalized inner product is the usual inner product in Fock space multiplied by a wave amplitude renormalization constant. It is shown that the expectation values of all self-adjoint operators in the von Neumann algebra generated by the spin-momentum distribution observables in the scattering states approach asymptotically in time to their free counterparts. This von Neumann algebra is proven to be maximally abelian and any measurement of spins and momenta can be described in terms of operators in this algebra. The wave amplitude renormalization is necessary since only in this case does the spin-momentum distribution of the scattering states approach asymptotically in time to their free counterparts (incoming and outgoing states). Since one has an explicit expression for the asymptotic creation operators, one may compute transition probabilities, with the cut-offs, for any scattering process in a non-perturbative fashion. (Diss. Abstr. Int., B)

49164 SOME EXAMPLES OF IU(3.1) INVARIANT ANALYTIC EXTENSIONS OF N-POINT FUNCTIONS. Santilli, R. M.; Roman, P.; Ktorides, C. N. (Boston Univ.). Particles Nucl.; 3: No. 6, 332-50(Jun 1972).

In the framework of the theory of inhomogeneous U(3,1) invariant analytic extensions of the n-point functions introduced previously, two- and three-point functions are studied, and their analyticity domains are explicitly constructed. (auth)

49165 ESTIMATES, RENORMALIZED CURRENTS, AND FIELD EQUATIONS FOR THE YUKAWA$_2$ FIELD THEORY. Dimock, Jonathan (Harvard Univ., Cambridge, Mass.). Ann. Phys. (N. Y.); 72: No. 1, 177-242(Jul 1972).

Mathematically rigorous field equations for the Yukawa quantum field theory in two-dimensional space—time are obtained. The renormalized boson current $j = -\lambda : \bar{\psi}\psi : + \delta m^2 \varphi$ and the fermion current $J = \lambda\psi\varphi$ are defined as bilinear forms continuous in space and time. As bilinear forms the boson field is shown to be twice continuously differentiable and the fermion field, once continuously differentiable. The identities $(\Box + m^2)\varphi = j$ and $[\gamma_0(\partial/\partial t) + \gamma_1(\partial/\partial x) + M]\psi = J$ are shown to hold. As distributions the terms in these equations define operators independent of all cutoffs. The results depend on detailed estimates of the renormalization cancellations in the theory. These estimates have other applications, one of which is a proof of the quadratic estimate dominating the fractional energy operator by the Hamiltonian. (auth)

49166 CANONICAL FORMALISM IN SPECIAL RELATIVITY. Pina, E. (Univ. Libre, Brussels). Bull. Cl. Sci., Acad. Roy. Belg.; 58: No. 1, 86-104(1972).

A covariant Hamiltonian description was introduced in the dynamics of charges and electromagnetic interaction. By a canonical transformation this Hamiltonian formalism was transformed to obtain the Dirac generators for any form of relativistic dynamics, as coefficients of a first degree polynomial in the ten translation and rotation velocities of the Poincaré transformation. The Currie's world line conditions were generalized to any form of the dynamics. The explicit relation between the covariant field variables and the more usual 3-dimensional Fourier variables was derived. (auth)

49167 SPECIAL THEORY OF RELATIVITY: A CRITICAL ANALYSIS. Essen, L. Oxford Science Research Papers 5. New York; Oxford University Press (1971). 30p. $1.70.

The critical analysis covers the foundations of the theory, Einstein's principles, the basic process of measurement in terms of defined units, the synchronization of time and simultaniety, Lorentz transformations, dilation of time, clock comparisons, the Doppler effect, the clock paradox, explanations in terms of the gravitational field and in terms of special relativity, and consequences of the paradox. Also treated are rotation and gravitational effects, a critical examination of the foundations of the theory, and relevant experiments. (J.F.P.)

49168 VACUUM FOR EXTERNAL—FIELD PROBLEMS. Labonte, G.; Capri, A. Z. (Univ. of Alberta, Edmonton). Nuovo Cim.; 10B: No. 2, 583-91(11 Aug 1972).

Quantum fields in interaction with external potentials are studied, and it is shown that it is possible to define quanta of the interpolating field thus permitting an unambiguous definition of the time-dependent vacuum and diagonalization of the Hamiltonian. Furthermore, it is possible to identify the quanta of the interpolating field as "in particles." (auth)

49169 SPIN-MOMENTUM DISTRIBUTION OBSERVABLES AND ASYMPTOTIC FIELDS FOR FERMION FIELDS WITH CUT-OFF SELF-INTERACTION. Prugovecki, E.; Manoukian, E. B. (Univ. of Toronto). Nuovo Cim.; 10B: No. 2, 421-46(11 Aug 1972).

For spin-$\frac{1}{2}$ fields with an interaction density which is an even-degree polynomial in the field and its derivatives the interaction Hamiltonian H_I with space and ultraviolet cut-offs is a bounded operator on Fock space. Asymptotic creation and annihilation operators $a_\pm^\#$ can be constructed by means of the Kato—Mugibayashi method from the creation and annihilation operators $a^\#$. For any eigenvector Φ of the total Hamiltonian $H = H_0 + H_I$ partial isometrics $\Omega_\pm$ can be defined so that $a_\pm^\# = \Omega_\pm a^\# \Omega_\pm^*$ on the ranges $F_\pm$ of $\Omega_\pm$. Since the existence of a ground state of H can be proven, the existence of at least one pair $\Omega_\pm$ is assured. It is shown that the W*-algebra $R(\tilde{O})$ generated by the spin-momentum distribution observables of the form $\int \rho a^* a$ is maximally Abelian. The existence of the wave operators $\Omega_\pm$ and the completeness of the spin-momentum distribution observables allow one to describe the measurement of any spin and momentum of an arbitrary finite number of particles. (auth)

Gravitation and General Relativity

Refer also to abstracts 48740, 48746, 48747, 48974, 49023, and 49112.

49170 ORBITAL MOTION OF A ROTATING BODY AND ITS STABILITY FROM THE POINT OF VIEW OF THE RELATIVISTIC THEORY OF GRAVITATION. Ryabushko, A. P. Vestsi Akad. Navuk BSSR, Ser. Fiz.-Mat. Navuk; No. 6, 66-75(1971). (In Russian).

The effect of properly rotating bodies on their forward motion was investigated on the basis of the equations of motion previously introduced in a post-Newton approximation. Secular effects were evaluated: rotation of the apsid line, the precession of the orbital plane, and change of the angle of inclination of the orbit. In exceptional cases (a pulsar) these effects proved to be significant. Bilinear bodies, according to their characteristic momenta were members which commonly were disregarded, but had a strong effect in these cases. The problem of stability of orbital movement is briefly discussed; such motion appears unstable according to Lyapunov and stable according to Lagrange. (tr-auth)

49171 SELF-FOCUSING AND SELF-TRAPPING OF GRAVITATIONAL WAVES. Olsen, S. O. Nature (London) Phys. Sci.; 238: No. 79, 12-13(3 Jul 1972).

It is stated that the large amount of gravitational energy emitted from the galactic center indicated by the observations of Weber (Phys. Rev. Lett. 25: 180 (1970)) (10^2 to 10^4 solar masses/yr) appears to be at variance with established astrophysics. An attempt is made to reconcile this using the concept of self-focusing and self-trapping of radiation. Analogies with optics are discussed. (UK)

49172 SOME GRAVITATIONAL FIELD SATISFYING THE EINSTEIN EQUATION. Jakubowicz, A.; Szczepanek, W. (Inst. of Mathematics, Szczecin, Poland. Technical Univ., Szczecin, Poland). Tensor; 23: No. 2, 157-8(May 1972).

The Einstein field equation is solved, and the particular form of the solved gravitational field which admits the parallel field of contravariant vector and simultaneously the parallel field of covariant trivector is found. (J.F.P.)

49173 SOME COORDINATE SYSTEM FOR THE EINSTEIN SPACE—TIMES OF THE TYPE N. Jakubowicz, Antoni (Inst. of Mathematics, Szczecin, Poland. Technical Univ., Szczecin, Poland). Tensor; 23: No. 2, 159-61(May 1972).

A simpler form is found for the Einstein space—times of type N using a given transformation of the coordinate system. (J.F.P.)

49174 SOME ASPECTS OF MACH'S PRINCIPLE WITHIN THE THEORY OF GENERAL RELATIVITY. Golden, Norman Jerome. Laramie, Wyo.; Univ. of Wyoming (1971). 473p. University Microfilms Order No. 72-13,023.

Thesis.

A large number of statements have been called Mach's principle by one author or another. In general, all of these statements have in common the idea that somehow, local phenomena are connected with the large scale distribution of matter in the universe. To Einstein, the incorporation of Mach's principle into general relativity meant the exhaustive determination of the metric tensor, g_{ij}, by the energy-stress-momentum tensor of the universe. He was to find that this feature was not included in his theory. Philosophical discussion of the significance of Ernst Mach's empiricism is important to understand the setting of Mach's ideas within the framework of the philosophical views of the days in which he wrote. Mach's notions in fact were the start of a modern version of empiricism called logical positivism. Logical positivism, in the hands of the Vienna Circle developed into those ideas which are today called operationalism. Operationalism, it is suggested, is neither a satisfactory view of science nor a sufficiently tolerant doctrine of meaning for modern science. A large number of authors, who have written on Mach's principle or used Mach's principle (in one of its forms) as the basis for their work on general relativity are discussed. Chief among these are J. A. Wheeler, D. W. Sciama, H. Thirring, D. R. Brill and J. Cohen, L. Bass and F. A. E. Pirani, Ya. B. Zeldovich, M. Bunge, H. Hönl, et al., J. Ehlers and E. Schücking, M. Sachs as well as A. Einstein. R. H. Dicke's work is discussed also, although it does not fall into the mold of a theory within the framework of general relativity. A calculation is performed on a model universe representing a picture of Newton's rotating bucket experiment in which the frame of reference is that in which the bucket is at rest. This model, which can only be applied in principle, has a thin shell of matter rotating with a definite constant angular velocity. Calculation then shows that for this model, inertial frames are "dragged" perfectly by the rotating matter shell. The geodesic equations are then written for a test body in the interior of the matter shell and they show precisely that the Coriolis and centrifugal forces are those of a rotating body. Hence, transformation to a frame in which the Coriolis and centrifugal forces disappear, leads to a model universe in which the "star compass' and the "inertial compass" coincide. A translation of a significant journal article concerning Mach's principle is included. Some of the mathematical details left out for the sake of simplifying the discussion in the calculation of the rotating shell universe are shown. (Diss. Abstr. Int., B)

49175 DIRAC ELECTRONS IN A GRAVITATIONAL FIELD. Rosenman, Julian Gary. Austin, Tex.; Univ. of Texas (1971). 125p. University Microfilms Order No. 72-19,661.

Thesis.

An analysis of Dirac electrons in a gravitational field is carried out using the general relativistic Dirac equation. The Dirac equation is introduced in an elementary way. The flat space Dirac equation is then generalized so that it will hold in an arbitrary pseudo-Riemannian spacetime. The absence of a gravitational interaction Lagrangian is discussed. The interaction of electrons with linearized (weak) gravitation is extensively discussed. Several problems are proposed and solved, among them, the Schwarzschild scattering differential cross section, the energy levels of the "gravitational hydrogen atom," and the nongeodesic motion of electrons in the classical limit. The interaction of electrons is studied in certain exact solutions to Einstein's field equations. In particular, gravitational fields of types O and N and of the Kerr–Schild type are used for background metrics. An exact solution of the neutrino (massless electron) equation is found for PP gravitational wave metrics. The necessity of dealing with the negative energy states of the neutrino is explicitly exhibited. Difficulties with the gravitational S-matrix are discussed in the context of the LSZ axioms. The difficulties in constructing a unitary S-matrix for gravitation are pointed out. Finally, some speculations are advanced as to the nature of quantum gravitational interactions. (Diss. Abstr. Int., B)

49176 NEW THEORY OF GRAVITATION. Yilmaz, H. (Perception Tech. Corp., Winchester, Mass.). Nuovo Cim.; 10B: No. 1, 79-101(11 Jul 1972).

A locally Lorentz-invariant curved-space theory of gravitation, where the local field is a massless, spin-2 field, φ_μ^ν, of Pauli–Fierz type, is presented. In this theory $g_{\mu\nu}$ is no longer the gravitational potential itself, but reduces to a functional $g_{\mu\nu}(\varphi_\alpha^\beta)$ of φ_μ^ν. Several rigorous and a general iteration solution of this type are exhibited. The static central-body problem reduces to author's 1958 theory as a special case $\varphi_\mu^\nu \rightarrow \varphi_0^0 = \varphi$ and $\partial^\mu \varphi_\mu^\nu \rightarrow \partial^0 \varphi = 0$ exactly, so that as in that theory the three classical tests are satisfied. (auth)

49177 LIGHTLIKE BEHAVIOR OF PARTICLES IN A SCHWARZSCHILD FIELD. Jaffe, Jack; Shapiro, Irwin I. (Massachusetts Inst. of Tech., Cambridge). Phys. Rev., D; 6: No. 2, 405-6(15 Jul 1972).

Above a transition velocity, $v_t \simeq c/\sqrt{2}$, test particles moving in a Schwarzschild field behave in a lightlike manner by appearing to slow down as they approach the source of the field. (auth)

49178 GRAVITATIONAL SPIN INTERACTION. Wald, Robert (Princeton Univ., N. J.). Phys. Rev., D; 6: No. 2, 406-13(15 Jul 1972).

The gravitational spin interaction is investigated by studying the deviation from geodesic motion of spinning test bodies. The force on a spinning test body at rest in the exterior field of an arbitrary stationary, rotating source is evaluated and found to be given by $\vec{F} = -\vec{\nabla}[-\vec{S} \cdot \vec{J} + 3(\hat{r} \cdot \vec{J})(\hat{r} \cdot \vec{S})/r^3] + O(1/r^5)$, where $\vec{S}$ is the spin of the test body, $\vec{J}$ is the angular momentum of the source of the gravitational field, and geometrized units $G = c = 1$ are used. Thus, the gravitational spin-spin force has the same form as the force between two dipoles in electromagnetism except that its sign is opposite, i.e., "north pole" attracts "north pole" in gravitational spin-spin interaction. The gravitational spin-spin torque, previously investigated by Schiff, Mashhoon, and Wilkins, also has opposite sign to the corresponding electromagnetic dipole-dipole torque. The sign of the spin-spin force agrees with that predicted by Hawking on the basis of the fact that less energy can be extracted from colliding black holes if their spins are parallel rather than antiparallel. Furthermore, it is shown that the spin-interaction energy quantitatively accounts for the angular momentum dependence in Hawking's formula for the upper limit for energy released from colliding black holes. The gravitational spin-orbit force is also investigated, and it is found to differ in form from the corresponding electromagnetic spin-orbit force. (auth)

49179 QUANTUM FIELD THEORY ON A CURVED BACKGROUND. Lichnerowicz, A. pp 36-51 of Mathematical Problems in Theories of Particles and Fields. Goteborg; Chalmers Tekniska Hogskola (1971).

From Mathematical problems in theories of particles and fields conference; Goteborg, Sweden (7 Jun 1971). See CONF-710650; CTH-ITP-71-16.

The tensor and spinor propagators corresponding to a given curved space-time are studied. These propagators are extensions of the scalar propagator D of Jordan–Pauli which play an important role in the usual quantum field theory. It is possible to construct, by means of these propagators, commutators and anticommutators for the various free fields in the framework of general relativity theory. (auth) (FHS) (Sweden)

49180 EVOLUTION EQUATION IN RELATIVE KINEMATICS OF CONTINUOUS SYSTEMS IN GENERAL RELATIVITY. Grassini, Renato. Ric. Mat.; 20: No. 2, 241-52(1971). (In Italian).

Reference marks on the congruence of the current line in V_4 of a continuous system are examined in terms of space vectors and a continuous system. The velocity vector of relative evolution and the equation of evolution are developed. The conditions of rigidity, irrotationality, and isochoricity are analyzed. (K.S.W.)

49181 RELATIVITY AND GRAVITATION. Proceedings of an International Seminar Held at Technion City, Israel, July 1969. Kuper, Charles G.; Peres, Asher (eds.). New York; Gordon and Breach, Science Publishers, Inc. (1971). 331p. $24.50. (CONF-690713).

The conference included 36 papers one of which was abstracted previously in NSA. For an abstract of this paper see abstract number 23: 51993. Separate abstracts were prepared for 35 papers. (J.F.P.)

For abstracts of individual papers see: 48746—48748, 49023, 49114, 49125, 49155—49159 and 49182—49205.

49182 CLASS OF EXACT SOLUTIONS FOR THE MOTION OF A PARTICLE IN A MONOPOLE-PROLATE QUADRUPOLE FIELD. Armenti, Angelo Jr.; Havas, Peter (Temple Univ., Philadelphia). pp 1-15 of Relativity and Gravitation. /Kuper, Charles G. (ed.). New York; Gordon and Breach, Science Publishers, Inc. (1971).

From Seminar on relativity and gravitation; Haifa, Israel (15 Jul 1969). See CONF-690713.

The motion of a particle is considered in the combined gravitational field of a monopole and a prolate quadrupole, both in Newtonian mechanics and in general relativity (using the metric found by Erez and Rosen). In Newtonian mechanics there exists a class of exact solutions, corresponding to circular motion with constant angular velocity in planes parallel to the plane of symmetry of the quadrupole; similar solutions exist in general relativity if the quadrupole moment is not too small. The motion is stable in a wide region, up to a maximum value of the radius, reached at the plane of symmetry; this value coincides exactly with the minimum value of the radius for stable circular orbits within the plane of symmetry for all Newtonian solutions, as well as for the general relativistic solutions. Possible generalizations of these these results are indicated. (auth)

49183 DOES A GRAVITATIONAL FIELD INFLUENCE CHEMICAL EQUILIBRIA? Balazs, Nandor L. (State Univ. of New York, Stony Brook). pp 17-21 of Relativity and Gravitation. /Kuper, Charles G. (ed.). New York; Gordon and Breach, Science Publishers, Inc. (1971).

From Seminar on relativity and gravitation; Haifa, Israel (15 Jul 1969). See CONF-690713.

It is shown that the usual thermodynamical equilibrium conditions for chemically reacting mixtures in the presence of a gravitational field are incorrectly given if the rest masses change; the correct conditions coincide (up to small terms) with the conditions derived from relativistic thermodynamics; these conditions imply that the chemical equilibrium constant obtained for ideal gas reactions depends on the gravitational potential. (auth)

49184 STATUS OF CANONICAL QUANTIZATION. Bergmann, Peter G. (Syracuse Univ., N. Y.). pp 23-39 of Relativity and Gravitation. /Kuper, Charles G. (ed.). New York; Gordon and Breach, Science Publishers, Inc. (1971).

From Seminar on relativity and gravitation; Haifa, Israel (15 Jul 1969). See CONF-690713.

Various approaches to canonical (local) quantization are related to each other, and their current status evaluated. Beginning with a review of Hamiltonian theory with first-class constraints this review discusses Schrödinger quantization, Hamilton–Jacobi theory (with and without superspace), Feynman integrals, and the sandwich conjecture, and concludes with some speculations of a general nature. (auth)

49185 SELECTED TOPICS IN THE PROBLEM OF ENERGY AND RADIATION. Bicak, J. (Charles Univ., Prague). pp 47-67 of Relativity and Gravitation. /Kuper, Charles G. (ed.). New York; Gordon and Breach, Science Publishers, Inc. (1971).

From Seminar on relativity and gravitation; Haifa, Israel (15 Jul 1969). See CONF-690713.

The selected topics from the energy–radiation branch of relativity theory include the uniqueness of energy–momentun tensors in special relativity theory, energy–momentum complexes of the gravitational field, energy of perturbations of the gravitational field and some related problems, exact radiative solutions of Einstein equations, and the exact radiative solution representing a bounded system. (J.F.P.)

49186 APPROXIMATE RADIATIVE SOLUTIONS OF EINSTEIN–MAXWELL EQUATIONS. Choquet-Bruhat, Y. (Faculte des Sciences, Paris). pp 81-6 of Relativity and Gravitation. /Kuper, Charles G. (ed.). New York; Gordon and Breach, Science Publishers, Inc. (1971).

From Seminar on relativity and gravitation; Haifa, Israel (15 Jul 1969). See CONF-690713.

A general method derived from the W.K.B. method is used to construct approximate solutions of the Einstein–Maxwell equations, where the metric is the sum of a background metric and a rapidly oscillating perturbation, whereas the electromagnetic field is the sum of a background field and a rapidly oscillating one, which is found to be of the pure radiation type. It is shown that despite the nonlinear character of the Einstein equations, the significant part of the perturbation in the metric and the radiative electromagnetic field propagate along the rays associated with wave fronts of the background metric and satisfy ordinary linear differential equations along those rays. (J.F.P.)

49187 ROTATING EINSTEIN–ROSEN BRIDGE. Cohen, Jeffrey M. (Goddard Space Flight Center, New York). pp 87-97 of Relativity and Gravitation. /Kuper, Charles G. (ed.). New York; Gordon and Breach, Science Publishers, Inc. (1971).

From Seminar on relativity and gravitation; Haifa, Israel (15 Jul 1969). See CONF-690713.

The Einstein–Rosen bridge is a model for a nonrotating mass constructed out of nothing but curved empty space. It is shown that the model can be generalized to describe a slowly rotating mass with a well defined angular momentum. The gravitational radius of a Einstein–Rosen bridge of mass 2.1 solar masses is about 6 km, while the physical radius of certain recently found neutron-star models of the same mass is only about twice as large. (auth)

49188 DISTRIBUTION THEORY AND THIN SHELLS IN GENERAL RELATIVITY. Cohen, Marion D. (Newark Coll. of Engineering, N. J.); Cohen, Jeffrey M. pp 99-104 of Relativity and Gravitation. /Kuper, Charles G. (ed.). New York; Gordon and Breach, Science Publishers, Inc. (1971).

From Seminar on relativity and gravitation; Haifa, Israel (15 Jul 1969). See CONF-690713.

The problem, previously unsolved, of computing the value of $\int_{-\infty}^{\infty} \theta\delta\, dx$, where θ is the Heaviside function and δ is the Dirac delta function comes up quite frequently in physics, particularly in the general-relativistic theory of thin shells. It is shown that the value is undetermined—i.e., it depends on the particular physical situation—but that it must always lie between 0 and 1. Several intuitive arguments are presented which lead to the same conclusion. If the value were $\frac{1}{2}$, as is generally believed, then the results would be inconsistent with Einstein's equations. (auth)

49189 TWISTORS, SYMPLECTIC STRUCTURE, AND LAGRANGE'S IDENTITY. Crampin, M.; Pirani, F. A. E. (London Univ.). pp 105-10 of Relativity and Gravitation. /Kuper, Charles G. (ed.). New York; Gordon and Breach, Science Publishers, Inc. (1971).

From Seminar on relativity and gravitation; Haifa, Israel (15 Jul 1969). See CONF-690713.

The relation between the natural symplectic structure on the cotangent bundle over a space–time manifold, Lagrange's identity for Jacobi fields, and the symplectic structure developed by Penrose in his theory of twistors is described. (auth)

49190 GRAVITATIONAL–SCALAR FIELD COUPLING. Deser, S.; Higbie, J. (Brandeis Univ., Waltham, Mass.). pp 123-44 of Relativity and Gravitation. /Kuper, Charles G. (ed.). New York; Gordon and Breach, Science Publishers, Inc. (1971).

From Seminar on relativity and gravitation; Haifa, Israel (15 Jul 1969). See CONF-690713.

Spherically symmetric initial solutions of the system gravitation plus massless scalar field, generated by a physical "particle" source of both, are obtained. These solutions exhibit unusual behavior in terms of the source parameters (bare mass m_0, Einstein constant $\varkappa$, scalar coupling constant f, and source size ϵ): There are no solutions for some ranges of these parameters, while two (nonsingular) branches exist elsewhere. In each of the limits $f \rightarrow 0$, $\varkappa \rightarrow 0$ or $\epsilon \rightarrow \infty$ there is a normal and an anomalous branch, the latter involving essential singularities in f, $\varkappa$, ϵ^{-1} through factors $\sim f^2\epsilon^{-1} \exp [\epsilon^2 f^{-2}\varkappa^{-1}]$ in the mass and the fields. There is a minimum finite particle extension for all solutions. The analogous system: particle source of the scalar-tensor gravitational field is also treated in the scalar-tensor theory of gravitation, where the results are qualitatively as in general relativity. (auth)

49191 KINETIC THEORY OF GASES IN GENERAL RELATIVITY. Ehlers, Juergen (Univ. of Texas, Austin). pp 145-54 of Relativity and Gravitation. /Kuper, Charles G. (ed.). New York; Gordon and Breach, Science Publishers, Inc. (1971).

From Seminar on relativity and gravitation; Haifa, Israel (15 Jul 1969). See CONF-690713.

The concepts and assumptions of the kinetic theory of gases are outlined, and some theorems are stated. Also the application to cosmology of the relation of the distribution function and the specific intensity of radiation considered as a photon gas is described. (J.F.P.)

49192 NEW TECHNIQUE FOR THE ANALYSIS OF SINGULARITIES. Feinblum, David (Weizmann Inst. of Science, Rehovot, Israel. State Univ. of New York, Albany). pp 155-7 of Relativity and Gravitation. /Kuper, Charles G. (ed.). New York; Gordon and Breach, Science Publishers, Inc. (1971).

From Seminar on relativity and gravitation; Haifa, Israel (15 Jul 1969). See CONF-690713.

The new technique for the analysis of singularities is used for the example of the metric $ds^2 = \cos x(dy^2 - dx^2) + 2 \sin x\, dx\, dy$ with the point (x,y) identified with $(x + 2m\pi, y + 2m\pi)$ for integral m and n. (J.F.P.)

49193 QUANTUM SPACE–TIME AND GENERAL RELATIVITY. Finkelstein, David (Yeshiva Univ., New York). pp 159-61 of Relativity and Gravitation. /Kuper, Charles G. (ed.). New York; Gordon and Breach, Science Publishers, Inc. (1971).

From Seminar on relativity and gravitation; Haifa, Israel (15 Jul 1969). See CONF-690713.

The modifications required by general relativity in an attempt to overcome the divergency problem of quantum field theory by introducing a quantum theory of space–time are discussed. The electrodynamical and hydrodynamical treatments, and the physical theory for the search for the quantum of space–time, the chronon, are described. (J.F.P.)

49194 POSSIBILITY OF COSMOLOGICAL FOUNDATIONS FOR CLASSICAL AND RELATIVISTIC THERMODYNAMICS. Gal-Or, Benjamin (Technion-Israel Inst. of Tech., Haifa). pp 173-6 of Relativity and Gravitation. /Kuper, Charles G. (ed.). New York; Gordon and Breach, Science Publishers, Inc. (1971).

From Seminar on relativity and gravitation; Haifa, Israel (15 Jul 1969). See CONF-690713.

It is shown that the fundamental problem of thermodynamical irreversibility in general relativity theory can be solved if account is taken of the cosmological fact that space itself is expanding. In this context the fact of the universe expansion is taken as the point of departure in laying new foundations for thermodynamics. (J.F.P.)

49195 EQUATIONS OF MOTION IN GENERAL RELATIVITY. Goldberg, Joshua N. (Syracuse Univ., N. Y.). pp 189-93 of Relativity and Gravitation. /Kuper, Charles G. (ed.). New York; Gordon and Breach, Science Publishers, Inc. (1971).

From Seminar on relativity and gravitation; Haifa, Israel (15 Jul 1969). See CONF-690713.

An attempt is made to understand the preliminary description of Newman for the general relativistic equations of motion. The motion of point and spinning particles is discussed. (J.F.P.)

49196 MODIFICATION OF THE CLASSICAL GRAVITATIONAL FIELD EQUATIONS DUE TO A VIRTUAL QUANTIZED MATTER FIELD. Halpern, L. (Univ. of Windsor, Ont.). pp 195-8 of Relativity and Gravitation. /Kuper, Charles G. (ed.). New York; Gordon and Breach, Science Publishers, Inc. (1971).

From Seminar on relativity and gravitation; Haifa, Israel (15 Jul 1969). See CONF-690713.

The modifications of the gravitational field equations due to a virtual quantized electromagnetic field are studied including the additional mass due to the attraction of conducting planes in vacuum. (J.F.P.)

49197 APPROXIMATE SOLUTIONS OF EINSTEIN'S EQUATIONS. Kerner, Richard (Institut Henri Poincare, Paris). pp 205-11 of Relativity and Gravitation. /Kuper, Charles G. (ed.). New York; Gordon and Breach, Science Publishers, Inc. (1971).

From Seminar on relativity and gravitation; Haifa, Israel (15 Jul 1969). See CONF-690713.

An outline of a method for investigating the approximate solutions of the Einstein equations is given illustrating it by the Minkowskian case. Any solution of the Einstein equations can be regarded as a hypersurface of dimension four imbedded into an appropriate Euclidean space. The deformations are investigated of the imbedded manifold given by the variations of the imbedding functions instead of producing small disturbances of the metric itself. (J.F.P.)

49198 THIRD PRINCIPLE OF RELATIVITY. Knapecz, G. pp 213-19 of Relativity and Gravitation. /Kuper, Charles G. (ed.). New York; Gordon and Breach, Science Publishers, Inc. (1971).

From Seminar on relativity and gravitation; Haifa, Israel (15 Jul 1969). See CONF-690713.

The concept of the geometric object ("couplet") is generalized. The new objects obey the transitivity and the identity functional equations for infinitesimal general coordinate transformations. By the solution of these functional equations the existence of the new geometric objects is proved. It is shown that the spinors of the Poincaré group also belong to these objects. The new geometric objects may be applied in the description of nature if one requires the expression of natural laws to be covariant under infinitesimal general coordinate transformations. (auth)

49199 ANALOGUES OF THE LANDAU–LIFSHITZ PSEUDOTENSOR. Lubkin, Elihu (Univ. of Wisconsin, Milwaukee). pp 225-38 of Relativity and Gravitation. /Kuper, Charles G. (ed.). New York; Gordon and Breach, Science Publishers, Inc. (1971).

From Seminar on relativity and gravitation; Haifa, Israel (15 Jul 1969). See CONF-690713.

The identities of Landau and Lifshitz which express the ten mechanical conservation laws in Einstein's theory of gravitation are reviewed in slightly generalized form. The expressions obtained are used to construct ten conservation laws related to deSitter symmetry in the same way that the usual ten laws are related to Poincaré symmetry. The pattern of conservation laws associated with symmetry of a tail zone, or of a symmetric comparison background, is stated as a conjecture. Another illustration is given, in which an antisymmetric form is compared to the canonical antisymmetric form. (auth)

49200 CLASSIFICATION OF SPACE–TIME CURVATURE TENSOR. Mishra, R. S. (Banaras Hindu Univ., India). pp 239-52 of Relativity and Gravitation. /Kuper, Charles G. (ed.). New York; Gordon and Breach, Science Publishers, Inc. (1971).

From Seminar on relativity and gravitation; Haifa, Israel (15 Jul 1969). See CONF-690713.

The classification theory of the curvature tensor of the space–time V_4, which is the operational space of general relativity theory, is developed. The prerequisites, admissible Ch_2 and Ch_4 characteristics, the canonical form of K, and the admissibility of different characteristics are treated. (J.F.P.)

49201 NEW SOLUTION OF THE FIELD EQUATIONS WITH PERFECT FLUID. Misra, R. M.; Narain, Udit (Univ. of Gorakhpur, India). pp 253-8 of Relativity and Gravitation. /Kuper, Charles G. (ed.). New York; Gordon and Breach, Science Publishers, Inc. (1971).

From Seminar on relativity and gravitation; Haifa, Israel (15 Jul 1969). See CONF-690713.

A new solution of Einstein's field equations is presented. The universe represented by it contains perfect fluid, the density of which depends upon the position, even when the cosmological constant is taken to be zero. Under certain conditions this solution reduces to Einstein's static solution. (auth)

49202 INVARIANT EVOLUTION OF GRAVITATIONAL FIELD. Peres, Asher (Technion-Israel Inst. of Tech., Haifa). pp 269-73 of Relativity and Gravitation. /Kuper, Charles G. (ed.). New York; Gordon and Breach, Science Publishers, Inc. (1971).

From Seminar on relativity and gravitation; Haifa, Israel (15 Jul 1969). See CONF-690713.

The initial values of the gravitational field variables, at some time $t = 0$, carry the imprint of their entire evolution, past and future. They can be used to write "equations of motion for absolute invariants," and to compute dynamical properties (such as collision cross sections) without ever leaving the hypersurface $t = 0$. (auth)

49203 COSMOLOGICAL THEORY OF GRAVITATION. Prokhovnik, S. J. (Inst. of Theoretical Astronomy, Cambridge, Eng.). pp 275-82 of Relativity and Gravitation. /Kuper, Charles G. (ed.). New York; Gordon and Breach, Science Publishers, Inc. (1971).

From Seminar on relativity and gravitation; Haifa, Israel (15 Jul 1969). See CONF-690713.

A cosmological model, based on a uniformly expanding universe, can be represented as an acceleration field whose properties may provide the basis for the phenomenon of gravitation. The gravitational "constant" emerges as a parametric attribute of the model. The equivalence of gravitational and inertial mass is seen to be due to their common dependence on the field associated with a body. (auth)

49204 GRAVITATIONAL FIELDS IN MATTER. Szekeres, Peter (London Univ.). pp 305-8 of Relativity and Gravitation. /Kuper, Charles G. (ed.). New York; Gordon and Breach, Science Publishers, Inc. (1971).

From Seminar on relativity and gravitation; Haifa, Israel (15 Jul 1969). See CONF-690713.

The Weyl tensor having the algebraic properties of a vacuum curvature tensor is used to discuss the actual generation and propagation of gravitational waves in the sources. The gravitational equivalent of the classical electromagnetic treatment in the linearized approximation for a corpuscular medium with quadrupole moments induced on the individual constituent atoms is given. The phenomenon of refraction for gravitational waves is found in a form more familiar from electromagnetism. (J.F.P.)

49205 GRAVITATIONAL RADIATION EXPERIMENTS. Weber, J. (Inst. for Advanced Study, Princeton, N. J.). pp 309-22 of Relativity and Gravitation. /Kuper, Charles G. (ed.). New York; Gordon and Breach, Science Publishers, Inc. (1971).

From Seminar on relativity and gravitation; Haifa, Israel (15 Jul 1969). See CONF-690713.

Gravitational radiation experiments were carried out by observing coincidences of sudden increases in amplitude on detectors 1000 kilometers apart, at Argonne National Laboratory and the University of Maryland. The detectors measure the Fourier transform of the Riemann curvature tensor. A brief history is given and followed by discussion of the statistics and experiments to rule out electromagnetic, seismic, and cosmic-ray particle interactions. These data support a conclusion that gravitational radiation is being observed. The exact theory of the antenna directivity is given. The earth rotates the antenna, therefore the time of each coincidence is some measure of the direction of the source. The largest peak of the intensity pattern is in the direction of the galactic center. (auth)

49206 CONSTRAINT RELATIONS IN TWO-TENSOR GRAVITY. Lawrence, J. K.; Toton, E. T. (Univ., Vienna). Ann. Phys. (N. Y.); 72: No. 1, 293-303(Jul 1972).

A (3 + 1)-dimensional decomposition is made of a two-tensor theory of gravity proposed by Salam et al. It is found that the gauge invariance roles of the two tensors are very symmetric, so that the massiveness or masslessness of the fields is ambiguous. Constraint equations are derived by elimination of gauge variables. The form of the constraints casts doubt on the sign of the total energy of the theory. (auth)

49207 ASYMPTOTIC LIMIT FOR THE SPEED OF SOUND IN A SYSTEM OF RELATIVISTICALLY INTERACTING PARTICLES. Bowers, Richard L. (Univ. of Texas, Austin). Phys. Rev. Lett.; 29: No. 8, 509-11(21 Aug 1972).

A relativistic many-body theory is used to evaluate the equation of state to lowest order in the weak coupling constant for a dense system of electrons and neutrinos interacting through the universal Fermi interaction. The asymptotic limit for the speed of sound $v_s \leq c/\sqrt{3}$ is obtained; it is conjectured that a large class of relativistic interactions leads to the same limit. (auth)

49208 FIELD OBSERVABLES IN THE RADIATION GAUGE FOR THE MAXWELL AND SPIN 2 FIELDS. Oliveira, Colber G. (Centro Brasileiro de Pesquisas Fisicas, Rio de Janeiro). Notas Fis., Cent. Brasil. Pesqui. Fis.; 18: No. 12, 155-75(1972).

It is shown that given the potentials for spin-1 zero-rest-mass fields, the process of producing field potentials which commute with the generator of gauge transformations is equivalent to modifying the classical commutator (the Poisson bracket), which holds for these initial potentials, to the Dirac bracket which describes the commutation algebra for the gauge invariant field potentials in the radiation gauge. This result is extended for spin-2 zero-rest-mass fields without self-interaction. This last case is taken as the weak field approximation of the full nonlinear gravitational field equations of general relativity. (auth)

49209 ORBITAL AND VORTICAL MOTION IN THE KERR METRIC. De Felice, F.; Calvani, M. (Gruppo di Astrofisica Teorica, Padua. Univ., Padua). Nuovo Cim.; 10B: No. 2, 447-58(11 Aug 1972).

The motion is analyzed, in general, in the Kerr metric with the use of first integrals. Some of the high-energy particles and photons are found to move in a giant vortex around the axis of symmetry above and below the equatorial plane, dragged by the gravitational field. (auth)

49210 GENERALLY COVARIANT MASSIVE GRAVITATION. Aichelburg, P. C.; Mansouri, R. (Univ., Vienna). Nuovo Cim.; 10B: No. 2, 483-97(11 Aug 1972).

A discussion is given of the theory of finite-range gravitation proposed by Freund et al. Generalization of this theory leads to a generally covariant massive two-tensor theory of gravitation. The theory differs from the f-g theory proposed by Salam et al, by the mixing term of the tensor fields. It is shown that the linearized as well as the exact theory contains eight dynamically independent degrees of freedom. A Kerr–Schild type of ansatz for the fields makes the field equations linear. As special solutions plane-fronted waves with parallel rays are obtained. Many of the results are also valid for the f-g theory. (auth)

49211 WKB APPROXIMATION AND OSCILLATORY BEHAVIOUR OF NULL GEODESICS IN GENERAL RELATIVITY. Dautcourt, G. (Central Inst. for Astrophysics, Berlin). Bull. Acad. Pol. Sci., Ser. Sci., Math., Astron. Phys.; 20: No. 5, 417-20(1972).

The periodic appearance of focal points along light-like geodesics in general-relativistic space-times, a phenomenon apparently first discovered by Ozsvath and Schücking, is studied using a WKB approximation for the areal distance. (auth)

49212 CENTRIFUGAL FIELD INDUCED BY A ROTATING SHELL. Lausberg, A.; Simon, R. (Univ., Liege). Bull. Cl. Sci., Acad. Roy. Belg.; 58: No. 1, 58-67(1972).

In order to derive from the field equations of general relativity theory an expression of the centrifugal field induced by a slowly rotating shell, it is necessary to separate the "centrifugal" terms from "gravitational" terms of the same order of magnitude. A solution to this problem is obtained by means of an assumption about the "self-Coriolis" stresses which contribute to the source of the centrifugal terms: these stresses are supposed to have a vanishing trace. The result shows a centrifugal field with the classical form in the empty space inside the shell, if the relative thickness of the latter is sufficiently small. (auth)

49213 TWO CLASSES OF SOLUTIONS OF NULL ELECTROMAGNETIC RADIATION. De, U. K.; Banerjee, A. (Jadavpur Univ., Calcutta). Progr. Theor. Phys. (Kyoto); 47: No. 4, 1204-9(Apr 1972).

Two sets of solutions of Einstein–Maxwell equations representing null electromagnetic fields are presented. One of the sets corresponds to plane waves where the propagation vector K^α is divergence free, and the other represents waves with $K^\alpha_{;\alpha} \neq 0$. (auth)

49214 MACH'S PRINCIPLE, MASS, AND THE FINE STRUCTURE CONSTANT. Tomozawa, Yukio (Univ. of Michigan, Ann Arbor). Found. Phys.; 2: No. 1, 27-34(Jan 1972).

A modified form of Mach's principle is proposed, and its consequences are discussed. (auth)

Scattering Theory

Refer also to abstracts 49040, 49128, 49134, 49163, and 49459.

49215 (JINR-E2-6157, pp 92-118) TOPICS IN HIGH ENERGY SCATTERING. Logunov, A. A.; Nguyen van Hieu (Inst. of High Energy Physics, Serpukhov, USSR).

The asymptotic properties of scattering amplitudes are studied. The main attention is given to the physical inter-relations between the crossing processes. These relations become very simple at high energies. (auth)

49216 (LBL-759(Rev.)) FOUNDATIONS OF S-MATRIX THEORY. I. THEORY AND MEASUREMENT. Stapp, Henry P. (California Univ., Berkeley. Lawrence Berkeley Lab.). 13 Jun 1972. Contract W-7405-eng-48. 56p. Dep. NTIS.

A systematic development of S-matrix theory is given. The general problem of the connection between theory and experiment, and hence the specific problems of measurement and interpretation in relativistic quantum theory are treated. (auth)

49217 (LBL-956) FOUNDATIONS OF S-MATRIX THEORY. II. MACROCAUSALITY. Stapp, Henry P. (California Univ., Berkeley. Lawrence Berkeley Lab.). 17 Apr 1972. Contract W-7405-eng-48. 44p. Dep. NTIS.

A systematic development of S-matrix theory is given. The macrocausality property, which is a formulation of the condition that the interactions of longest range are those carried by stable particles, is described. (auth)

49218 (LBL-959) FOUNDATIONS OF S-MATRIX THEORY. III. THE NORMAL ANALYTIC STRUCTURE. Stapp, Henry P. (California Univ., Berkeley. Lawrence Berkeley Lab.). 2 Jun 1972. Contract W-7405-eng-48. 27p. Dep. NTIS.

A systematic development of S-matrix theory is given. The normal analytic structure is described which is the property that each scattering function is analytic at all physical points not lying on any positive-α Landau surface corresponding to a connected diagram and that near most points lying on any such surface it is the limit of an analytic function taken from directions lying in a specified cone. (auth)

49219 ANALYTICITY PROPERTIES AND BOUNDS OF THE SCATTERING AMPLITUDES. Martin, Andre; Cheung, Franklin. Documents on Modern Physics. New York; Gordon and Breach, Science Publishers, Inc. (1970). 137p.

The treatment covers the unitarity relation, review of results of local field theory on analyticity properties of scattering amplitudes on the mass shell, the use of the positivity condition to enlarge the analyticity domain, determination of R and extension of the domain of validity of fixed transfer dispersion relations. Also covered are the Froissart bound and related topics, extension of the analyticity domains of the pion–pion scattering amplitude, spin complications, review of asymptotic bounds, and absolute bounds and geometrical restructions of the $\pi\pi$ amplitude in the primitive domain s, t, u, <4. (J.F.P.)

49220 POTENTIAL SCATTERING IN THE EIKONAL APPROXIMATION. Joachain, Charles J.; Mund, Ernest H. (Univ. Libre, Brussels). Bull. Cl. Sci., Acad. Roy. Belg.; 57: No. 9. 1043-53(1971).

The eikonal wave function and scattering amplitude for potential scattering are obtained by using elliptic confocal coordinates to evaluate the total Green's function in the short wave length limit. The derivation provides a simple way of analyzing some of the basic assumptions involved in deriving the eikonal approximation. (auth)

49221 ANALYTICITY AND INTEGRAL RELATIONS FOR THE SCATTERING AMPLITUDE. Mnatsakanova, M. N.; Popova, An. M.; Vernov, Yu. S. (Moscow State Univ.). Phys. Lett.; 40B: No. 2, 174-6(26 Jun 1972).

A set of integral relations connecting the real and imaginary parts of the forward scattering amplitude is obtained. (auth)

49222 ELEMENTARY PARTICLE PHYSICS AND SCATTERING THEORY. VOLUME 2. Chretien, M.; Schweber, S. S. (eds.). Brandeis University Summer Institute in Theoretical Physics, 1967. New York; Gordon and Breach, Science Publishers, Inc. (1970). 444p.

There were four lectures included. Separate abstracts were prepared for all lectures. (J.F.P.)

For abstracts of individual lectures see: 49136, 49223, 49224, and 49783.

49223 TOPICS IN SCATTERING THEORY. Gottfried, K. (Cornell Univ., Ithaca, N. Y.). pp 125-200 of Elementary Particle Physics and Scattering Theory. Vol. 2. /Chretien, M. (ed.). New York; Gordon and Breach, Science Publishers, Inc. (1970).

The lectures on scattering theory cover scattering by a bound system, elastic scattering and the optical model, production and decay of unstable particles, and sum rules for inelastic cross sections. (J.F.P.)

49224 ANALYTICITY PROPERTIES AND BOUNDS OF THE SCATTERING AMPLITUDES. Martin, Andre (CERN, Geneva); Cheung, Franklin. pp 303-434 of Elementary Particle Physics and Scattering Theory. Vol. 2. /Chretien, M. (ed.). New York; Gordon and Breach, Science Publishers, Inc. (1970).

The lectures cover preliminaries on the unitarity relation, a review of the results of local field theory on analyticity properties of scattering amplitudes on the mass shell, the use of the positivity condition to enlarge the analyticity domain, and determination of R and extension of the domain of fixed momentum transfer dispersion relation. Also covered are the Froissart bound and related topics, extension of the pion–pion analyticity domain, spin complications, review of asymptotic bounds, and absolute bound and geometrical restrictions of the $\pi\pi$ amplitude in the primitive domain s, t, u > 4. (J.F.P.)

49225 INVARIANT IMBEDDING AND A NONLINEAR SCATTERING PROCESS. Bellman, Richard (Univ. of Southern California, Los Angeles). J. Math. Anal. Appl.; 38: No. 3, 611-18(Jun 1972).

The discussion of invariant imbedding for a nonlinear scattering process covers the one-dimensional scattering process, transport equations, monotonicity property, the Riccati equation, successive approximations, monotonicity, convergence, and a more general nonlinear term. (J.F.P.)

49226 UNITARY PARAMETRIZATION OF THREE-BODY OBSERVABLES. Brayshaw, D. D. (Stanford Univ., Calif.). Phys. Rev., D; 6: No. 1, 196-9(1 Jul 1972).

The three-particle unitarity relations are solved explicitly in order to derive a general representation for the measurable three-body amplitudes. The representation is characterized by a well-defined set of real parameters which are the equivalent of a phase-shift analysis for the three-body problem. The resulting parametrization is suitable for both the data analysis of three-particle final states, and as a starting point for a three-body phenomenology. (auth)

49227 INTERACTION TIME MEASUREMENT AND CAUSALITY. Papp, E. (Polytechnic Inst., Cluj). Nuovo Cim.; 10B: No. 1, 69-78(11 Jul 1972).

The consistency of the interaction time shift evaluation problem with respect to the cases when, respectively, there is present or not an explicit energy dependence is proved. It is shown, especially in the case of nuclear reactions described by the R-matrix, that the strong causality condition turns out to be expressible in terms of a physically verifiable "idealized" time shift measurement condition. (auth)

49228 VARIATIONAL METHOD FOR THE EFFECTIVE TWO-PARTICLE FORMULATION OF THE THREE-BODY COLLISION PROBLEM. Alt, E. O. (Univ., Mainz); Sandhas, W.; Grassberger, P. Phys. Rev., D; 6: No. 2, 432-41(15 Jul 1972).

A variational approach for bound-state scattering due to Carew and Rosenberg is applied to an effective potential formulation of the three-body problem given previously. This allows for several simplifications of their method. Its effectiveness is studied numerically in the model of three identical spinless particles interacting via Yukawa potentials. (auth)

49229 METHOD FOR EXPRESSING DIRAC SPINOR AMPLITUDES IN TERMS OF INVARIANTS AND APPLICATION TO THE CALCULATION OF CROSS SECTIONS. Fearing, Harold W.; Silbar, Richard R. (Los Alamos Scientific Lab., N. Mex.). Phys. Rev., D; 6: No. 2, 471-7(15 Jul 1972).

A method is described for expressing spinor amplitudes $M = \bar{u}(p',s')\Gamma u(p,s)$ in terms of invariants. The method also provides a simple formula for the square of M summed on spins. When Γ contains more than five terms or has more than two γ-matrices per term this formula involves the evaluation of fewer and shorter traces than the usual trace technique. Thus this should be a useful computational device for calculating cross sections. The methods presented here are independent of the spinor representation, but can be easily specialized to the important helicity case. A number of other possible applications of the amplitude formula are also briefly discussed. (auth)

49230 PARTIAL-WAVE ANALYSIS OF SPINOR BETHE–SALPETER EQUATIONS FOR SINGLE-PARTICLE EXCHANGE. Kubis, Joseph J. (Los Alamos Scientific Lab., N. Mex.). Phys. Rev., D; 6: No. 2, 547-64(15 Jul 1972).

The Bethe–Salpeter equation for spin-$\frac{1}{2}$ particles is analyzed by the use of helicity amplitudes. Decomposition into partial-wave amplitudes reduces the equation into three subsets of eight coupled integral equations, one set for singlet states, one set for triplet states ($L = J$), and one set for the coupled triplet states ($L = J \pm 1$). Both positive- and negative-energy states are included. Matrix elements are written for interaction kernels that come from single-particle exchange. The cases treated are scalar, pseudoscalar, and photon exchanges. Detailed expressions are given in the general case when all particles are off the mass shell, both for the full Bethe–Salpeter equation and for all the partial-wave equations. (auth)

49231 RELATIVISTIC THREE-BODY PROBLEM IN CONFIGURATION REPRESENTATION. Vinogradov, V. M. (Joint Inst. for Nuclear Research, Dubna, USSR). Teor. Mat. Fiz.; 12: No. 1, 29-39(Jul 1972). (In Russian).

On the basis of the three-dimensional formulation of the quantum field theory the configuration space in the relativistic three-body problem is introduced. A finite-difference analog of the Schrödinger equation in terms of relative variables is obtained. On the basis of these equations a relativistic generalization of the Faddeev integral equations for the wave function is formulated. Difficulties caused by the integral character of the relations between the relative variables are pointed out. (auth)

49232 PROBLEM OF A FAMILY OF NONPARALLEL REGGE TRAJECTORIES. Kolomytsev, V. I. (Inst. of Mathematics, Kiev). Teor. Mat. Fiz.; 12: No. 1, 40-7(Jul 1972). (In Russian).

A cause of the arising of a family of parallel Regge trajectories in the framework of the group theoretical approach to the conspiracy problem is investigated from the analytical and group theoretical points of view. It is shown that it is impossible for a definite class of groups including the group SO(4,2) to build up a group theoretical model leading to nonparallel trajectories. The proof is based on the study of the analytical properties of the functions appearing in the integral formula which connects the matrix elements of the irreducible representations of the group under consideration restricted to the subgroup SU(1,1) with those of the latter. (auth)

49233 RELATIVISTIC HADRON DYNAMICS: A PRESENTATION OF SOME MODELS FOR THE RELATIVISTIC S-MATRIX. Milgram, Michael Stephen. Toronto; Univ. of Toronto (1971). National Library of Canada, Ottawa.

Thesis.

The treatment covers a brief introduction to the principles of S-matrix theory; some of the recent advances of Veneziano and others are detailed and an indication is given of how the author's work fits into this setting; some advances in the author's models are given; and the contributions are given insofar as the experimental analysis of $\pi^- p \rightarrow \pi^- p\omega$ at 6.9 GeV/c is concerned. Technical details of the model and useful formulas are given. (Diss. Abstr. Int., B)

49234 EFFECTS OF UNITARITY ON THE MULTIPERIPHERAL MODEL. Auerbach, S. (Univ. of California, Santa Barbara); Aviv, R.; Sugar, R.; Blankenbecler, R. Phys. Rev. Lett.; 29: No. 8, 522-5(21 Aug 1972).

Two models are presented for which the full multiparticle S matrix is unitary at high energies. The production mechanism is based on the multiperipheral model. It is shown that the elastic-scattering amplitude contains a new type of cut in the angular-momentum plane, which is dynamical in origin. This unitarity cut plays a crucial role in enforcing the Froissart bound. (auth)

49235 SYMMETRY RELATIONS FOR DEEP-INELASTIC PROCESSES. Lipkin, Harry J. (National Accelerator Lab., Batavia, Ill. Argonne National Lab., Ill.); Paschos, E. A. Phys. Rev. Lett.; 29: No. 8, 525-9(21 Aug 1972).

Relations between structure functions conventionally obtained from quark–parton or light-cone models are shown to follow from model-independent symmetry assumptions common in hadron scattering. Exotic t-channel exchanges are forbidden. No strong-interaction symmetry beyond isospin is assumed, and SU(3) is used only for vertices involving currents. Relations originally derived for nucleon targets hold for any isospin mirror pair, and apply to complex targets appearing in the Mueller formalism for inclusive processes in the target fragmentation region. New relations are derived. (auth)

49236 EXPANSION OF THE HELICITY AMPLITUDE IN TERMS OF UNITARY REPRESENTATIONS OF THE LORENTZ GROUP. Verdiev, I. A. (Physical Inst., Baku). Ann. Phys. (N. Y.); 72: No. 1, 139-70(Jul 1972).

Expansions of one-particle helicity states with nonzero mass and mass equal to zero in terms of irreducible unitary representations (IUR) of the Lorentz group are considered. The expansion of helicity amplitude (HA) of particles with nonzero mass in terms of matrix elements of IUR of the Lorentz group is performed by regarding it as a function given over the double-sheeted hyperboloid. It is shown that the scattering amplitude as well as the HA, in Lorentz representation, has the simple symmetry properties under space reflection and time reversal. In the HA expansion where the square momentum transfer enters an explicit function these amplitudes are free of kinematic singularities. The integral representation for partial HA is also obtained. This representation gives correct threshold behavior, exponential decrease at large values of total angular momentum, J, and defines the partial HA as an analytical function in a definite half-plane. (2 figures) (auth)

PHYSICS (LOW-TEMPERATURE)

49237 (ORNL–4779, pp 21-6) LOW-TEMPERATURE PROPERTIES. Apr 1972.

In Solid State Division annual progress report for period ending December 31, 1971.

HELIUM (SUPERFLUID)— Bose–Einstein condensation in, neutron inelastic scattering study of
NEUTRONS, FAST— effects on vanadium
NIOBIUM ALLOYS— Nb–Ti, ac losses in superconducting
SUPERFLUIDITY— Bose–Einstein condensation in helium, neutron inelastic scattering study of
VANADIUM— radioinduced defects and flux pinning in, fast-neutron (D.L.C.)

Superfluidity

49238 THEORY OF SUPERFLUIDITY OF THE TWO-DIMENSIONAL AND ONE-DIMENSIONAL BOSE SYSTEMS. **Popov, V. N.** (Inst. of Mathematics, Leningrad). **Teor. Mat. Fiz.; 11: No. 3, 354-65(Jun 1972).** (In Russian).

By means of the continual integration method the hydrodynamic Hamiltonian is constructed for the two-dimensional and one-dimensional Bose systems. The form of the Hamiltonian shows the superfluidity and the presence of a two-liquid hydrodynamics at low temperatures in spite of the absence of condensate. The last property follows from the fact that the one-particle Green functions decrease at large distances as the inverse power of r in the two-dimensional systems at $T \neq 0$ and in the one-dimensional systems at $T = 0$. A model of the two-dimensional Bose gas of low density is calculated, for which the thermodynamical functions and the equations of the phase transition curve are found. It is shown that taking into account of quantum vortices in the two-dimensional Bose system does not change the power character of the Green function asymptotics at large distances. (auth)

49239 CAN LIQUID MOLECULAR HYDROGEN BE SUPERFLUID. **Ginzburg, V. L.; Sobyanin, A. A.** (Lebedev Inst. of Physics, Moscow). **JETP Lett. (USSR) (Engl. Transl.); 15: No. 6, 242-4(20 Mar 1972).**

Translated from Zh. Eksp. Teor. Fiz., Pis'ma Red.; 15: No. 6, 343-5(20 Mar 1972).

The possibility that any Bose liquid should become superfluid at a certain temperature, provided it does not solidify at a higher temperature, is explored in relation to liquid molecular H_2. The conditions under which this might occur are discussed. (M.H.R.)

49240 THEORY OF DILUTE SOLUTIONS OF ^{3}He IN SUPERFLUID ^{4}He. **Kulas, Russll Howard. Amherst, Mass.; Univ. of Massachusetts (1972). 187p. University Microfilms Order No. 72-19,476.**

Thesis.

The theory of ^{3}He impurities in ^{4}He is investigated to develop the microscopic theory of the ^{3}He quasi particles. A review of the phenomenological theories of the Fermi liquid properties of the ^{3}He subsystem is presented. This includes the thermodynamic calculation by Bardeen, Baym, and Pines of the long-wavelength effective interaction between the He quasi particles. These phenomenological and thermodynamic theories have precipitated and set the context for the development of the microscopic theory. A trial wave function is proposed for the ground state of the mixture of the form $\phi_o = F_g \varphi_o$, where φ_o is the ground state of pure ^{3}He and F_g is a Jastrow-type function to account for altered correlations due to the lighter mass of the He atoms. F_g is determined variationally. From the new ground state, radial distribution functions g(r) (α,β) for 3–3 and 3–4 pairs are computed. They are compared with the similar functions determined by Massey, Woo and Tan by a more complicated variational calculation. Qualitatively, their g(r) (3,4) is slightly better, but the g(r) (3,3) is a considerable improvement. Corrections to the BPP α and $\mu_3 - \mu_4$ are inadequate because of an approximation in the variational procedure. An improvement to overcome this difficulty is suggested. Perturbation theory is used with correlated basis functions (CBF) to calculate the ^{3}He quasi-particle energy and scattering amplitude to second order, so as to include the effects of the phonon-induced interaction. Before that, a diagonal metric procedure is developed which eliminates the ambiguity in the scattering amplitude arising from the nonorthogonality of the CBF. $m_3^* = 2.08\ m_3$ is obtained without renormalization of the phonon spectrum. An effective interaction V_q is obtained which is qualitatively similar to the phenomenological forms. The first microscopic calculation of the long-wavelength limit of V_q is obtained from perturbation theory. Its magnitude has a 33% uncertainty, while the improvement of the ground state wave function is awaited. A comparison is made with the CBF theories of McMillan and Woo, Tan and Massey. The theory favors that of McMillan, but removes the nonorthogonality ambiguity, and replaces his phenomenological portion with a microscopic calculation. A divergence of views arises with respect to Woo, Tan, and Massey which requires further investigation. (Diss. Abstr. Int., B)

49241 POSSIBLE ORIGIN OF THE QUANTIZED VORTICES IN He II. **Putterman, S. J.** (Univ. of California, Los Angeles); **Kac, M.; Uhlenbeck, G. E. Phys. Rev. Lett.; 29: No. 9, 546-9 (28 Aug 1972).**

Based on considerations of the rotating ideal Bose gas it is suggested that the quantized vortex lines can enter the superfluid contained in a rotating bucket through an adiabatic transformation of the ground state. (auth)

49242 OBSERVATIONS ON THE ESCAPE OF NEGATIVE IONS FROM PRESSURIZED, TURBULENT He II. **Sitton, Donald M.** (Univ. of Virginia, Charlottesville). **Phys. Rev. Lett.; 29: No. 9, 542-6(28 Aug 1972).**

Data on the capture and escape of negative ions in turbulent He II are reported for various pressures. The results are consistent with a revised version of Vinen's dimensional theory and previous experimental results on rotating He II. A model for vortex annihilation is developed which allows the turbulence theory to be expressed in terms of a single dimensionless constant which is measured. (auth)

49243 THERMAL EXCITATION OF FOURTH SOUND IN HELIUM II. **Wiechert, H.; Schmidt, R.** (Johannes Gutenberg Univ., Mainz). **Phys. Lett.; 40A: No. 5, 421-2(14 Aug 1972).**

It was experimentally verified, that fourth sound can be excited not only mechanically but also thermally. The pressure amplitudes of the generated fourth sound waves were measured between 0.8 K and the lambda point. (auth)

Superconductivity

Refer also to abstracts 48130, 49720, 49723, 49762, and 49776.

49244 (LA-tr–72-22) CONSIDERATION OF THE ECONOMY FOR SUPERCONDUCTING DC POWER TRANSMISSION. **Ihara, Seijiro; Horigome, Takashi. Translated for Los Alamos Scientific Lab., N. Mex.), from Cryog. Eng. (Tokyo); 5: No. 1, 8-17(1970). 20p. Dep. NTIS.**

Resistive-cryogenic dc cable systems or superconducting dc cable systems are being actively investigated for underground transmission. It is interesting to compare each cable system from the viewpoints of techniques and economics. A conventional dc cable system, resistive-cryogenic dc cable system, and superconducting dc cable system are compared here. Results from this comparison are: (1) The break-even power of the superconducting cable system is greatly affected by the value of transmitting voltage; e.g., in the case of 220 kV transmitting voltage, break-even power is about 5 GW, while for 880 kV it is about 2 GW; (2) In the case where the transmitting power is more than 2 GW, the superconducting cable system is a more economical system than any other cable system; and (3) The economic domain of resistive-cryogenic cable systems is small. (tr-auth)

49245 (LBL–448) PULSED MAGNETIC FIELDS AND THE CRITICAL CURRENT DENSITIES OF SUPERCONDUCTING Nb_3Sn STRIPS IN THESE FIELDS. **Garrett, Terry Nathaniel** (California Univ., Berkeley. Lawrence Berkeley Lab.). **Dec 1971. Contract W-7405-eng-48. 40p. Dep. NTIS.**

A 70 KJ capacitor bank installation for the generation of pulsed magnetic fields is described. The construction of a helical magnet coil is discussed. The apparatus was used to study the effect of cold work on Nb_3Sn samples prepared by a new technique. The microstructure of the samples produced by this technique were examined using anodic etching. The microstructure consisted of a network of continuous Nb_3Sn filaments in a matrix of niobium. In a sample that was highly cold worked, the filaments were about one micron in diameter in a niobium matrix. A current density of 7.5×10^4 amp/cm^2 at 120 kG was obtained. (auth)

49246 (LBL–845) LOW FREQUENCY MEASUREMENTS WITH JOSEPHSON DEVICES. **Clarke, John** (California Univ., Berkeley. Lawrence Berkeley Lab.). **May 1972. Contract W-7405-eng-48. 5p. (CONF-720513–11). Dep. NTIS.**

From Applied superconductivity meeting; Annapolis, MD. (1 May 1972).

The application of Josephson devices to the measurement of low frequency magnetic fields and voltages is surveyed. The various types of Josephson junctions are described. The sensitivities of DC and RF SQUIDS are compared, and the noise limits of these devices discussed. The inherent noise of a device with inductance 10^{-9} H is expected to be of order 10^{-6} $\phi_o/\sqrt{\mathrm{Hz}}$, whereas the observed noise limit is typically $10^{-3} - 10^{-4}$ $\phi_o/\sqrt{\mathrm{Hz}}$, implying that noise in the room temperature electronics and/or environmental noise are the limiting factors. The magnetic field sensitivity of SQUIDS may be improved by the use of a flux transformer to perhaps 10^{-14} $\mathrm{T}/\sqrt{\mathrm{Hz}}$. Transformer coupling also greatly extends the range of SQUIDS used as voltmeters; in the ^{4}He temperature range, it is possible for the measurement to be Johnson noise limited in circuits whose resistance is $\lesssim 1\Omega$. (auth)

49247 (N–72–20725) FLUCTUATION-INDUCED CONDUCTIVITY OF SUPERCONDUCTORS ABOVE THE TRANSITION TEMPERATURE: REGULARIZATION OF THE MAKI DIAGRAM. (Maryland Univ., College Park. Dept. of Physics and Astronomy). [nd]. vp. (NASA-CR–125795). NTIS.

The Maki contribution to the conductivity above the superconducting transition temperature is regularized within the framework of the BCS theory. This is achieved through the renormalization of the impurity scattering vertex by inclusion of the effects of pair fluctuations. The conductivity is evaluated for a thin film. It depends only on the reduced temperature and the normal resistance per square. Fair agreement is found with Al films over a wide temperature range. Agreement is not found with experiments on Bi, Pb, and Ga films, which apparently contain a strong additional pair-breaking effect. The temperature range in which interactions among fluctuations become important in the Maki conductivity is generally larger than that given by the Ginzburg criterion. (auth) (STAR)

49248 VISCOUS MOTION OF VORTICES IN TYPE-II SUPERCONDUCTORS. Kupriyanov, M. Yu.; Likharev, K. K. (Moscow State Univ.). JETP Lett. (USSR) (Engl. Transl.); 15: No. 6, 247-50(20 Mar 1972).

Translated from Zh. Eksp. Teor. Fiz., Pis'ma Red.; 15: No. 6, 349-53(20 Mar 1972).

Gor'kov and Kopnin [Zh. Eksp. Teor. Fiz. 60, 2331(1971)] were the first to develop a consistent approach to the problem of viscous vortex motion in Type-II superconductors at $T = T_c$, using Ginzburg–Landau equations generalized to include the nonstationary case. This enabled them to calculate that part of the friction coefficient connected with the finite time of relaxation of the ordering parameter to the equilibrium value in superconductors with paramagnetic impurities. No account was taken, however, of the contribution made to the energy dissipation, and consequently to the friction coefficient, by the flow of the normal current component through the core of the vortex. This part of the friction coefficient was determined within the framework of the model developed previously, and the question of the value of the friction coefficient in a superconductor without paramagnetic impurities was discussed. (M.H.R.)

49249 SINGLE-PARTICLE TUNNELING IN SUPERCONDUCTING LEAD SINGLE CRYSTALS IN A MAGNETIC FIELD. Voloshkevich, A. G. (Inst. of Inorganic Chemistry, Novosibirsk, USSR). JETP Lett. (USSR) (Engl. Transl.)· 15: No. 6, 225-6 (20 Mar 1972).

Translated from Zh. Eksp. Teor. Fiz., Pis'ma Red.; 15: No. 6, 319-20(20 Mar 1972).

Tunnel junctions made of single-crystal lead, lead oxide, and a tin film (or a lead film) were investigated. Two singularities, corresponding to two values of the energy gap in the lead single crystal, were observed for all samples in the single-particle tunneling region. With increasing magnetic field parallel to the junction plane, a gradual coalescence of the singularities into one is observed. (M.H.R.)

49250 EFFECT OF CARBON COATING ON THE SUPERCONDUCTING TRANSITION TEMPERATURE OF THIN CARBON-DOPED MOLYBDENUM. Mikheeva, M. N.; Tsetlin, M. B.; Teplov, A. A.; Golyanov, V. M.; Demidov, A. P. JETP Lett. (USSR) (Engl. Transl.); 15: No. 6, 213-14(20 Mar 1972).

Translated from Zh. Eksp. Teor. Fiz., Pis'ma Red.; 15: No. 6, 303-4(20 Mar 1972).

Carbon-doped molybdenum films obtained by cathode sputtering at a Kr pressure of 10^{-5} torr were investigated. The dependence of critical temperature on the carbon film thickness is shown. (M.H.R.)

49251 MAGNITNYE SISTEMY NA SVERKHPROVODNIKAKH. (Magnetic Systems in Superconductors). Zenkevich, V. B.; Sychev, V. V. Moscow; Izdatel'stvo Nauka (1972). 260p.

This monograph considers the theory of superconductivity, materials for coil construction, physical problems in solenoid winding, cryogenic technology, designs for supplying power to magnetic systems, and the design, fabrication, and operation of superconducting magnetic systems. The materials discussed are chiefly Nb_3Sn, and the two binary systems Nb–Ti, and Nb–Zr. Applications of the magnetic systems under scrutiny include MHD generators, plasma retention, and bubble chambers. (207 references) (K.S.W.)

49252 EFFECT OF INTERBAND INTERACTIONS ON THE CRITICAL TEMPERATURE OF THE SUPERCONDUCTING TRANSITION IN A SEMIMETAL. Kopaev, Yu. V.; Timerov, R. Kh. Sov. Phys.-Solid State (Engl. Transl.); 14: No. 1, 69-75(Jul 1972).

Translated from Fiz. Tverd. Tela; 14: No. 1, 86-94(Jan 1972).

The effect of dielectric pairing due to the Coulomb interaction of electrons from different bands and hybridization on the critical temperature T_c for the superconducting transition is studied. Under conditions where the interband and intraband interactions are comparable in value to each other numerical methods are used to show that T_c does not exceed the critical temperature T_{c_0} (calculated without taking the interband interaction into account) if the dielectric gap involves only Coulomb forces. On the contrary, interband hybridization permits an increase in T_c. Moreover if there is interband interelectronic repulsion, T_c as a function of the dopant concentration can pass through a maximum. (auth)

49253 BEHAVIOR OF STRESS RELAXATION DURING A SUPERCONDUCTING TRANSITION. Dotsenko, V. I.; Pustovalov, V. V.; Fomenko, V. S. (Inst. of Low Temperatures, Kharkov). Sov. Phys.-Solid State (Engl. Transl.); 14: No. 1, 161-4(Jul 1972).

Translated from Fiz. Tverd. Tela; 14: No. 1, 201-5(Jan 1972).

The stress relaxation method is used to study the effect of a superconducting transition on the macroscopic properties of plastic deformation in lead. It is shown that the state of the metal affects the magnitude of the stress relaxation and the normal–superconducting transition affects the relaxation process. The data obtained are compared both with other experimental results and with various theoretical ideas about the nature of the interaction between dislocations and conduction electrons and the mechanism by which a superconducting transition affects macroscopic properties. (auth)

49254 EXCITON MECHANISM FOR SUPERCONDUCTIVITY. Bulaevskii, L. N.; Kopaev, Yu. V.; Kukharenko, Yu. A. (Lebedev Inst. of Physics, Moscow). Sov. Phys.-Solid State (Engl. Transl.); 14: No. 1, 92-4(Jul 1972).

Translated from Fiz. Tverd. Tela; 14: No. 1, 114-16(Jan 1972).

The effectiveness of the interaction between conduction electrons is estimated in a semiconductor via a nonequilibrium system of excitons excited, for example, by light. It is shown that in ordinary isotropic semiconductors the conditions under which this interaction can lead to superconductivity are not satisfied. In layer structures such as MoS_2 and WSe_2, however, this exciton mechanism may turn out to be effective. (auth)

49255 ELECTRODYNAMIC PROPERTIES OF SUPERCONDUCTING POINT CONTACTS. Likharev, K. K.; Semenov, V. K. Radio Eng. Electron. Phys. (USSR) (Engl. Transl.); 16: No. 11, 1917-22(Nov 1971).

Translated from Radiotekh. Elektron.; 16: No. 11, 2167-72 (Nov 1971).

A theoretical discussion of the behavior of a superconducting point contact, conforming to the Aslamazov and Larkin (AL) model in a nonresonant wave system, is presented. Calculations of the maximum power, radiated by the contact, and of the contact behavior in the presence of an external harmonic influence are presented. (auth)

49256 TRANSITION FROM BULKLIKE BEHAVIOR TO JOSEPHSON-JUNCTION-LIKE BEHAVIOR IN SUPERCONDUCTING MICROBRIDGES. Song, Yeong-du; Rochlin, Gene I. (Univ. of California, Berkeley). Phys. Rev. Lett.; 29: No. 7, 416-19(14 Aug 1972).

The behavior of superconducting Sn and Sn In microbridges was studied as a function of physical parameters of the evaporated films. For a proper choice of mean free path and bridge size, a regime of ideal Josephson-junction-like behavior appears just below T_c. The data are in good agreement with recent calculations by Baratoff, Blackburn, and Schwartz. (auth)

49257 THERMAL CONDUCTIVITY OF SUPERCONDUCTING LEAD–INDIUM ALLOYS. Gupta, A. K.; Wolf, S. (Case Western Reserve Univ., Cleveland). Phys. Rev., B; 6: No. 7, 2595-2602(1 Oct 1972).

The thermal conductivity in the mixed state K_m of a series of lead–indium alloys containing from 3 to 21 at.% In was measured as a function of temperature and magnetic field. The temperature dependence of the thermal conductivities in the superconducting and normal states K_s and K_n, respectively, was also measured in the range from 1.35 to 7.5 K. In the mixed state, the main emphasis was on the region near the upper critical field, H_{c2}, where Caroli and Cyrot found theoretically that the electronic thermal conductivity of dirty type-II superconductors varies linearly with applied magnetic field. In order to compare with their theory it was necessary to separate the electronic and lattice thermal conductivities, and to analyze the lattice contribution in terms of the scattering by boundaries, point defects, and conduction electrons. The field dependence of the lattice thermal conductivity was then theoretically calculated and subtracted from the experimentally measured field dependence of the total thermal conductivity. The experimental results are in good agreement in the dirty limit but large deviations are observed as the indium concentration is reduced. The phonon mean free path due to scattering by point defects was found to be in reasonably good agreement with the Klemens theory. The upper critical fields H_{c2} obtained from K-vs-H curves were compared with the theory of Helfand and Werthamer. From the critical fields, the product of the electronic mean free path and the residual electrical resistivity was found to be $0.66 \times 10^{-11}\ \Omega\ \mathrm{cm}^2$. The coherence length in the pure limit ξ_0 was also computed from the data, and a value of 1060 Å was found. (auth)

49258 ELECTRONIC STRUCTURE OF SUPERCONDUCTORS WITH DILUTE MAGNETIC IMPURITIES. Kuemmel, Reiner (Univ. del Valle, Colombia). Phys. Rev., B; 6: No. 7, 2617-31(1 Oct 1972).

The Bogolyubov equations for the quasi-particle eigenfunctions of a superconductor with isolated magnetic impurities are derived. Impurity scattering is treated in the Born approximation, and the wave functions in the spatially varying pair potential are calculated by the WKBJ method of Bardeen, Kümmel, Jacobs, and Tewordt. The pair-breaking condition is established, and the spatial variation of the pair potential at the impurity site is determined for temperatures near the critical temperature and the absolute zero. A few bound states are found in the pair-potential well. The free energy is obtained as a function of a variational parameter and shows an increase due to the energies of the pair-broken states. (auth)

49259 THERMAL CONDUCTIVITY IN THE TWO-BAND MODEL OF SUPERCONDUCTING TRANSITION METALS CONTAINING NONMAGNETIC IMPURITIES. Kumar, Pramod; Gupta, S. N. (Univ. of Roorkee, India). Phys. Rev., B; 6: No. 7, 2642-7(1 Oct 1972).

Using the Green's-function formulation, an expression was derived for the thermal conductivity of transition-metal superconductors containing nonmagnetic impurities in the two-band model of Suhl, Matthias, and Walker (SMW). The calculations were carried out neglecting the interband electron–phonon coupling and taking the interband-scattering collision time $\tau_{sd} \approx 10^{-12}$sec. The thermal conductivity K is found to be the sum of two terms K_1 and K_2. K_1 is the dominating term and depends in a complicated manner on both energy gap parameters $\overline{\Delta}_s$ and $\overline{\Delta}_d$, due to s and d bands, respectively. On the other hand, K_2 depends only on $\overline{\Delta}_d$ and is smaller by a factor of $\sim 10^{-7}$. A log–log plot of thermal conductivity vs temperature turns out to be a straight-line curve with a slight change in its slope at a temperature which depends upon the impurity concentration. Furthermore, K is found to decrease with increase in impurity concentration. These qualitative features of the present study are in very good agreement with the recent experimental investigations of Anderson et al. on niobium and lend support to the validity of the SMW two-band-model theory. (auth)

49260 ANISOTROPY OF THE CRITICAL CURRENT DENSITY IN THE NbTi FILAMENTS OF ROUND COMPOSITE SUPERCONDUCTORS. Mathur, M. P.; Walker, M. S.; Deis, D. W.; Jones, C. K. (Westinghouse Research Labs., Pittsburgh). J. Appl. Phys.; 43: No. 9, 3831-3(Sep 1972).

Magnetization measurements were performed on several multifilament NbTi wires in transverse and longitudinal magnetic fields. The ratio of circumferential and axial critical current densities for the individual filaments is deduced from the measurements and appears to be an increasing function of the magnitude of the magnetic field and the amount of cold work in the filaments. The results suggest that filaments may be less stable in longitudinal magnetic fields than calculations utilizing standard critical current data would indicate. Transverse swept field magnetization data confirm the theory of coupling in the composite. (auth)

49261 ANISOTROPIES IN THE CRITICAL CURRENTS OF NbN FILMS. Saito, Y.; Anayama, T.; Moto, Y.; Onodera, Y. (Tohoku Univ., Sendai, Japan). J. Appl. Phys.; 43: No. 9, 3842-5(Sep 1972).

Anisotropies in the critical currents were measured for NbN films prepared by reactive sputtering. The I_c values are anisotropic with respect to the orientation of the external field in the plane perpendicular to the direction of the current flow in the film. The effects of substrate, field strength, and heat treatment on the $I_c - \theta$ characteristics were examined. The I_c values show an enhanced peak at $\theta = 90°$, where the external field is applied perpendicular to the film surface. The peak at $\theta = 90°$ is explained in terms of the film structure of NbN films, which show a columnar polycrystalline growth. (auth)

49262 SUPERCONDUCTING FOUNTAIN EFFECT. Clarke John; Freake, S. M. (Univ. of California, Berkeley). Phys. Rev. Lett.; 29: No. 9, 588-91(28 Aug 1972).

An effect analogous to the fountain effect in superfluid helium has been observed in a superconductor for the first time. A temperature gradient across a Pb/Pb point-contact junction produced a small supercurrent, which was detected by measuring the asymmetry of the critical current. (auth)

49263 DETECTION OF NMR USING A JOSEPHSON-JUNCTION MAGNETOMETER. Day, E. P. (Stanford Univ., Calif.). Phys. Rev. Lett.; 29: No. 9, 540-2(28 Aug 1972).

Nuclear magnetic resonance was detected by following changes in the steady-state value of the longitudinal magnetization with a Josephson-junction magnetometer. Unlike previous fast-passage detection methods, this mode of detection gives a signal amplitude of $2M_0$ independent of the resonance linewidth and the rf power level. Maximum-intensity signals from room-temperature LiF were obtained at 40 dB less power than that required for maximum signal using conventional adiabatic fast-passage detection methods. (auth)

49264 MICROSCOPIC THEORY OF TUNNELING: GENERAL THEORY AND APPLICATION TO THE STATIC IMPURITY. Duke, C. B.; Kleiman, G. G.; Stakelon, T. E. (Univ. of Illinois, Urbana). Phys. Rev., B; 6: No. 6, 2389-2409(15 Sep 1972).

A microscopic theory of impurity-assisted tunneling is constructed in which the current-carrying (extended) eigenstates of the average one-electron potential in a tunnel junction are utilized as the basis functions, which are mixed by the Hamiltonian associated with the presence of a static or dynamic impurity anywhere in the system. In such a system, the one-electron propagator and its concomitant current across the junction can be calculated at zero bias by standard techniques for manipulating temperature Green's functions. The presence of a finite bias across the junction is incorporated into the theory via the principle of rigid occupancy; i.e., the equilibrium occupation of the (current-carrying) many-body eigenstates of the system is taken to be unaffected by the presence of the bias. Therefore the rigid-occupancy hypothesis relates the nonequilibrium current flow to the equilibrium (zero-bias) properties of the junction system. Thus, a theory of nonequilibrium current flow not based on linear-response theory is obtained. This hypothesis is incorporated into the Matsubara perturbation theory by treating the chemical potentials of the left- and right-hand electrodes as separate Lagrangian multipliers determined after the completion of all Matsubara sums to be related by $\mu_R = \mu_L - eV$. Therefore, for purposes of constructing and solving Dyson's equations for the renormalized one-electron propagators, the theory reduces to the conventional equilibrium theory defined using distorted-wave (i.e., non-plane-wave) states. The perturbation theory is shown to yield the conventional one-electron-theory results for the case of a static impurity potential in the barrier. Resonant elastic tunneling through impurity states of energy E_r near the zero-bias Fermi energy ζ causes conductance minima (maxima) for $E_r(0) > \zeta$ [$E_r(0) < \zeta$]. The transfer-Hamiltonian results are recovered by expanding the transmission probability. (auth)

49265 SUPERCONDUCTIVITY AND ^{19}F SPIN–LATTICE RELAXATION IN THE K, Rb, AND Cs TUNGSTEN FLUOROXIDE BRONZES. Hubble III, Fred Forrest. Tallahassee; Florida State Univ. (1972). 116p. University Microfilms Order No. 72-16,588.

Thesis.

Tungsten fluoroxide bronzes are nonstoichiometric compounds of the general formula $M_xWO_{3-y}F_y$. For $0.08 \leq x \leq 0.30$ these compounds exhibit a hexagonal crystal phase, with a small mixture of a tetragonal II phase for the lower metal concentrations. Li has recently been shown to dissolve in the hexagonal phase of potassium tungsten bronze, K_xWO_3, to yield compounds of the general formula $K_xLi_yWO_3$. Hexagonal fluoroxide bronzes of the formulas $M_xWO_{3-x}F_x$ and $M_xLi_yWO_{3-x-y}F_{x+y}$ with M = K, Rb, or Cs were made and it was shown that they are superconductors with transition temperatures ranging from 0.8 K to 4.5 K. Magnetization experiments have been performed which show the upper critical magnetic fields at T = 0 K range from 4.0 to 9.4 kG. X-ray analysis of the samples was carried out, and the lattice parameters have been tabulated and increase with increasing alkali metal content. ^{19}F spin-lattice relaxation experiments have been performed on seven of the samples from 1.3 K to 4.8 K, and three of the samples were observed to become superconducting during these experiments. $Cs_xWO_{3-x}F_x$ with $x = 0.10$ and $x = 0.15$ became superconducting and exhibited the characteristic decrease in T_1 for temperatures immediately below T_c. The Cs sample with $x = 0.20$ also became superconducting, but T_1 was observed to rise exponentially for $T < T_c$ due to the 1 KG magnetic field employed in the measurements. The BCS energy gap parameter was measured from this exponential rise and found to be 3.6 kT_c. $Cs_{.30}WO_{2.70}F_{.30}$ and $Cs_{.10}Li_{.05}WO_{2.85}F_{.15}$ showed semiconductor-like relaxation over the temperature range examined, and $K_{.15}WO_{2.85}F_{.15}$ relaxed through paramagnetic impurities. The spin-lattice relaxation of $Rb_{.15}WO_{2.85}F_{.15}$ showed an anomalous rise with temperature and could not be characterized at these low temperatures. (Diss. Abstr. Int., B)

49266 NEUTRON SPECTROSCOPY OF SUPERCONDUCTORS. Allen, Philip B. (State Univ. of New York, Stony Brook). Phys. Rev., B; 6: No. 7, 2577-9(1 Oct 1972).

A complete understanding of the mechanism for superconductivity requires knowledge of the details of electrons, phonons, and their interactions, and can be summarized by the function $\alpha^2F(\omega)$. This function is often very similar to the phonon density of states $F(\omega) = \Sigma\delta(\omega-\omega_Q)$, which can be derived from an analysis of neutron-scattering data. It is pointed out here that the complete function $\alpha^2F(\omega)$ is also (in principle) contained in neutron-scattering data if the intrinsic linewidth γ_Q is measured as well as the dispersion relation ω_Q. It is shown that α^2F differs from F by having a weighting factor $2\gamma_Q/\pi N(0)\omega$ inside the summation, where N(0) is the electronic density of states at the Fermi surface for both spin orientations. The dimensionless coupling constant λ can also be expressed in terms of N(0), ω_Q, and γ_Q. In practice, for most superconductors, the average widths γ_Q are smaller than presently available resolution. However, for materials with a high density of states like $\beta-W$ superconductors, the widths γ_Q may be measurable. Also, the question of whether superconductivity arises predominantly from coupling to certain groups of phonons can be answered experimentally by searching for anomalously large widths. Estimates of average phonon widths are given for a variety of metals. (auth)

49267 MAGNETIC FLUX PENETRATION INTO SUPERCONDUCTING THIN FILMS. Peabody, Gerald E. (Harvard Univ., Cambridge, Mass.); Meservey, R. Phys. Rev., B; 6: No. 7, 2579-95(1 Oct 1972).

The absolute value of the penetration depth in Sn and Pb superconducting thin films was measured using a quantum-interference technique. The value of the penetration depth obtained for 1500-Å-thick films of Pb was 630 Å; the value for a 3000-Å-thick film of Sn was 770 Å, and for a 2000-Å-thick film was 730 Å. These results are probably consistent with the BCS microscopic theory within the experimental error, although a direct comparison between the theoretical and experimental values is made difficult by the uncertainty in the nonlocal correction for the film thickness. The temperature dependence of the penetration depth for Pb (measured for temperature less than 4.2 K) agrees with a previous measurement of Erbach et al. For Sn the temperature dependence deviates from the theoretically expected behavior near the transition temperature. Results are given to show that the critical current of a superconducting interferometer with two parallel junctions is not strictly periodic in the applied magnetic flux with a period equal to the flux quantum hc/2e because of the magnetic field dependence of the critical currents of the junctions. (auth)

49268 COMPARISON OF MICROWAVE-INDUCED CONSTANT-VOLTAGE STEPS IN Pb AND Sn JOSEPHSON JUNCTIONS. Bracken, T. Dan; Hamilton, W. O. (Stanford Univ., Calif.). Phys. Rev., B; 6: No. 7, 2603-9(1 Oct 1972).

The microwave-induced voltage steps at $V = nh\nu/2e$ in the current–voltage characteristics of lead and tin Josephson junctions have been compared using a superconducting-quantum-interference device (SQUID) as a null detector in a potentiometer with 2×10^{-13}-V resolution. The junctions are individually biased and then connected to the voltmeter by means of a superconducting mechanical switch. The incident microwave power is provided by two phase-locked x-band klystrons whose variable difference frequency is stable to better than 1 part in 10^{12}. The upper limit on the relative voltage difference between the $n = 15$ (300 μV) voltage steps for a Pb/PbO and Sn/SnO junction is $\Delta V/V \leq 5 \times 10^{-9}$. An apparent systematic error associated with switching prevents further absolute accuracy. (auth)

49269 SPECIFIC-HEAT AND MAGNETIC MEASUREMENTS IN SUPERCONDUCTING Ta–Nb ALLOYS. Rollins, R. W.; Clune, Lavern C. (Ohio Univ., Athens). Phys. Rev., B; 6: No. 7, 2609-17(1 Oct 1972).

The specific heats of Ta and the Ta–Nb alloys $Ta_{0.963}Nb_{0.037}$, $Ta_{0.86}Nb_{0.14}$, $Ta_{0.595}Nb_{0.405}$, and $Ta_{0.42}Nb_{0.58}$ were measured from 1.5 to 7 K in both normal and superconducting states. The electronic specific-heat coefficient γ and the Debye temperature Θ_D were obtained from normal-state measurements below 4.2 K. The electron–phonon coupling factor λ and the bare-band-structure density of states at the Fermi surface $N_{bs}(0)$, calculated from these results using McMillan's theory, show a smooth increase with increasing Nb concentration. The values of λ are also compared with the predictions of Hopfield's theory. The thermodynamic critical field $H_c(T)$ for these intermediate-coupling alloys was determined by integrating the difference between the normal and superconducting specific heat $\Delta C(T)$. A comparison with independent values of $H_c(T)$ obtained from magnetization measurements carried out on the same samples shows agreement at low temperatures and suggests the magnetic measurements tend to emphasize sample inhomogeneities particularly near T_c. Finally, λ is compared with other indicators of strong coupling in superconductors such as the deviation of $H_c(T)$ from T^2 behavior, $\Delta C/\gamma T_c$, $2\Delta(0)/k_BT_c$, and $H_c^2(0)/\gamma T_c^2$ determined for these alloys from the specific-heat measurements. (auth)

49270 EFFECT OF SUPERCONDUCTING FLUCTUATIONS ON THE SPIN RELAXATION OF QUASI-ONE-DIMENSIONAL COMPOUNDS. Weger, M. (Hebrew Univ., Jerusalem); Maniv, T.; Ron, Amiram; Bennemann, K. H. Phys. Rev. Lett.; 29: No. 9, 584-8(28 Aug 1972).

An investigation is made of the effect of order-parameter fluctuations on the nuclear relaxation time of superconducting A15 compounds. It is found that because of the one-dimensional chain structure of these compounds the fluctuations make an important contribution to the NMR. (auth)

49271 A15-STRUCTURE Mo–Re SUPERCONDUCTOR. Gavaler, J. R.; Janocko, M. A.; Jones, C. K. (Westinghouse Research Labs., Pittsburgh). Appl. Phys. Lett.; 21: No. 4, 179-80(15 Aug 1972).

An investigation of the properties of Mo–Re thin films was undertaken. Superconducting transition temperatures of up to ~15°K were observed in films which have an approximate composition of $Mo_{0.7}Re_{0.3}$. This increase in T_c of 2 to 3°K over the corresponding bulk values is attributed to the formation of a metastable A15 phase in the sputtered films of this composition. (auth)

49272 SECOND CONFERENCE ON SUPERCONDUCTING MATERIALS AND THE APPLICATIONS OF SUPERCONDUCTIVITY, AUSSOIS, FRANCE, MARCH 24, 1971. Rev. Phys. Appl.; 6: No. 4, 481-562(Dec 1971). (In French and English). (CONF-710352).

Fourteen papers are included, and a separate abstract was prepared for each of the four considered in scope for NSA. (M.H.R.)

For abstracts of individual papers see: 49273—49275 and 49301.

49273 PINNING DOWN OF VORTEX LINES IN SUPERCONDUCTORS. Bethoux, O. (CNRS, Grenoble, France). Rev. Phys. Appl.; 6: No. 4, 491-500(Dec 1971). (In French).

From second conference on superconducting materials and the applications of superconductivity; Aussois, France (24 May 1971). See CONF-710352.

The way in which the overall pinning force of the vortex lattice can be calculated from the critical or magnetization current is discussed. The various models and theories proposed during the last dozen years for calculating this overall force from the elementary interaction forces between the vortex lines and the structural inhomogeneities are briefly presented. The different mechanisms proposed to explain these interactions are exposed. (auth)

49274 INHOMOGENEOUS SUPERCONDUCTORS AND PROXIMITY EFFECTS. Burger, J. P.; Deutscher, G. (Univ. Paris, Orsay, France). Rev. Phys. Appl.; 6: No. 4, 505-7(Dec 1971). (In French).

From second conference on superconducting materials and the applications of superconductivity; Aussois, France (24 Mar 1971). See CONF-710352.

The pinning energy of a vortex lattice is investigated for the case where the energy of an individual vortex is a one-dimensional periodic function in space. The pinning energy of a normal inclusion embedded in a superconducting matrix is then calculated; the most favorable condition in which this energy is an increasing function of the magnetic field and temperature is determined. (auth)

49275 RECENT ADVANCES IN HEAT TRANSFER TO HELIUM I. Johannes, C. (L'Air Liquide, Sassenage, France). Rev. Phys. Appl.; 6: No. 4, 509-13(Dec 1971).

From second conference on superconducting materials and the applications of superconductivity; Aussois, France (24 Mar 1971). See CONF-710352.

Thermal exchange phenomena in He I are reviewed: pool boiling, thermosiphon boiling, and forced convection heat transfer. Relations between the critical nucleate boiling flux and different parameters are given. The use of hypercritical He is discussed. (auth)

49276 INTRINSIC STEPS ON THE CURRENT–VOLTAGE CHARACTERISTICS OF JOSEPHSON POINT CONTACTS. Bondarenko, S. I.; Dmitrienko, I. M.; Narbut, T. P. (Physico-technical Inst. of Low Temperatures, Kharkov). Sov. Phys.-Solid State(Eng. Transl.); 14: No. 2, 295-9(Aug 1972).

Translated from Fiz. Tverd. Tela- 14: No. 2, 354-9(Feb 1972).

An experimental study was made of, and an explanation was found for, the "intrinsic" steps on the current–voltage characteristics of metallic Josephson point contacts in a superconducting strip resonator. The position of these steps was found as a function of the resonator size, the contact position in the resonator, the temperature, and the normal resistance. The experimental results indirectly imply Josephson radiation from such contacts. (auth)

49277 SUPERCONDUCTIVITY OF BISMUTH PHASES PRODUCED AT PRESSURES UP TO 30 kbar. Il'ina, M. A.; Itskevich, E. S. (Inst. of High-Pressure Physics, Moscow). Sov. Phys.-Solid State(Eng. Transl.); 14: No. 2, 328-31(Aug 1972).

Translated from Fiz. Tverd. Tela- 14: No. 2, 395-8(Feb 1972).

Variation in the electrical resistance of bismuth was studied at pressures up to 30 kbar between room temperature and 1.8°K. Three critical temperatures for the transformation into the superconducting state were found at ~4.0, 7.0, and 8.0°K, which correspond to different high-pressure modifications of bismuth. In agreement with the data in the literature, $T_c \simeq 7.0$°K corresponds to the phase Bi III. The experiments which were done showed that the new bismuth phase reported in Sov. Phys.-Solid State, 8: 1873 (1967) goes into the superconducting state at $T_c \simeq 4.0$°K. The critical temperature $T_c \simeq 8.0$ to 8.2°K is probably for the modification Bi II. (auth)

49278 EFFECT OF PRESSURE ON THE SUPERCONDUCTIVITY OF NIOBIUM DISELENIDE. Il'ina, M. A.; Itskevich, E. S.; Kalyuzhnaya, G. A. (Inst. of High-Pressure Physics, Moscow). Sov. Phys.-Solid State(Eng. Transl.); 14: No. 2, 428-30(Aug 1972).

Translated from Fiz. Tverd. Tela- 14: No. 2, 515-17(Feb 1972).

Effect of pressures up to 100 kbar on the superconducting transition temperature T_c was investigated in lamellar $NbSe_2$. In the pressure range up to 60 kbar, there was a linear increase of T_c with $d \ln T_c/dP = 4 \cdot 10^{-2}$ kbar^{-1}. Above 60 kbar, a new modification of $NbSe_2$ occurs, with $T_c = 8.9$°K at P = 64 kbar and $d \ln T_c/dP = -(0.9 \pm 0.5) \cdot 10^{-2}$ kbar^{-1}. The rise in T_c with decrease of the interlamellar distance under pressure supports the view that interaction between the niobium planes is responsible for superconductivity in $NbSe_2$. (auth)

49279 SUPERCONDUCTIVITY IN A FERMI-LIQUID MODEL OF s–d ELECTRONS. Dunin, S. Z. (Moscow Engineering Physics Inst.). Sov. Phys.-Solid State(Eng. Transl.); 14: No. 2, 559-60(Aug 1972).

Translated from Fiz. Tverd. Tela- 14: No. 2, 651-2(Feb 1972).

The importance of the Fermi-liquid interaction is studied. Electromagnetic sound waves with phase velocities greater than the Fermi velocity of carriers can be expected in a system with two types of quasi particles whose Fermi velocities are close together. An equation is derived for the energy gap: $\Delta \cong 2 K_{max}/p_F \epsilon_F \exp(-1/\rho_0)$. There are no restrictions on ρ_0 as in the phonon mechanism, and a critical temperature as high as 200°K can be obtained in a two-component Fermi liquid with the Coulomb interaction, such as the system of S and d electrons in transition metals. (D.L.C.)

49280 HIGH FREQUENCY RESISTANCE OF SUPERCONDUCTORS CONDENSED ON COLD SUBSTRATES. Reichert, V.; Hasse, J. (Univ., Karlsruhe, Ger.). Z. Phys.; 254: No. 1, 10-27(1972). (In German).

A microwave cryostat is described, which enables us to measure the surface resistance of superconducting films in metastable states. In metastable disordered films often elevated transition temperatures are found. Surface resistance measurements can give information about electronic parameters of such films. In connection with dc-conductivity and critical-magnetic-field measurements, the mean free path, the penetration depth, and the coherence length were determined in the metastable and the annealed state. These values were compared with those expected from a free electron model. (auth)

49281 SPECIFIC HEAT OF SUPERCONDUCTORS WITH MAGNETIC IMPURITIES. Mueller-Hartmann, E.; Zittartz, J. (Kernforschungsanlage, Juelich, Ger.). Solid State Commun.; 11: No. 2, 401-4(15 Jul 1972).

The influence of the Kondo effect on the specific heat jump in dilute magnetic superconductors was calculated. It is pointed out that specific heat measurements are particularly useful to test pair breaking and the Kondo effect. (auth)

49282 FORCE-FREE FIELDS IN TYPE-II SUPERCONDUCTORS. Timms, W. E. (New Univ. of Ulster, Coleraine, Ireland). Phys. Lett.; 40A: No. 5, 427-8(14 Aug 1972).

It seems possible that, under certain field and current conditions, the critical current of a type-II superconductor is not determined simply by application of a Bean–London model, but by the joint use of the latter and a second equation. (auth)

49283 SUPERCONDUCTING AND MAGNETIC PROPERTIES OF $La_{1-x}Gd_xRu_2$, AND $La_{1-x}Pr_xRu_2$ MIXED CRYSTALS. Hillenbrand, B.; Wilhelm, M. (Siemens AG, Erlangen, Ger.). Phys. Lett.; 40A: No. 5, 387-8(14 Aug 1972).

$LaRu_2$ in contrast to $CeRu_2$ shows the normal T_c depression by magnetic rare earth ions. This depression is much larger for praseodymium than for gadolinium. (auth)

49284 TEMPERATURE DEPENDENCE OF THE INELASTIC REFLECTION OF LIGHT OFF A SUPERCONDUCTOR. Tilley, D. R. (Univ. of Essex, Eng.). Z. Phys.; 254: No. 1, 71-80 (1972).

A general formulation is given for the problem of scattering of light off the surface of a superconductor with the creation of two quasi-particles. The cross-section is evaluated at all temperatures for a pure superconductor; at zero temperature the result agrees with earlier calculations by Abrikosov and Falkovskii and by Tong and Maradudin. At zero temperature there is no scattering with a frequency shift ω of less than 2Δ; as the temperature increases the scattering for $\omega < 2\Delta$ increases progressively because of the increasing number of thermally excited quasi-particles. (auth)

49285 GINZBURG–LANDAU PARAMETERS $\kappa_1(T)$ AND $\kappa_2(T)$ IN THE VICINITY OF $1/\sqrt{2}$. Kumpf, U. (Max-Planck-Institut fuer Metallforschung, Stuttgart. Univ., Stuttgart). Phys. Status Solidi (b); 52: No. 2, 653-8(1 Aug 1972). (In German).

From magnetization measurements of Pb–Tl single crystals with $0.572 \leqq \kappa \leqq 0.948$, the temperature dependence of the generalized Ginzburg–Landau parameters $\kappa_1(T)$ and $\kappa_2(T)$ is determined. There is a discrepancy between $\kappa_1(T)$ and $\kappa_2(T)$ at the transition between type-I and type-II superconductivity for $T < T_c$. The behavior of $\kappa_1(T)$ and $\kappa_2(T)$ near the transition temperature T_c is compared with the relations given by the Neumann–Tewordt theory. (auth)

49286 CRITICAL TEMPERATURE AND CRITICAL CURRENT DENSITY OF SUPERCONDUCTING V–Ga–Al ALLOYS WITH A15 STRUCTURE. Mueller, A.; Voigt, H. (Seimens AG, Erlangen, Ger.). Phys. Kondens. Mater.; 14: No. 3, 185-99(1972).

V–Ga–Al alloys containing 68 to 82 at. % vanadium can be easily worked mechanically in the A2 phase and transformed into the superconducting A15 phase by subsequent heat treatment. The preparation, critical temperature and critical current density of the A15 phase are described. The critical current density, which at 5 Tesla is in the 10^4 to 10^5A/cm^2 range, is compared with values of technically used superconductors. Ternary V–Ga–Al alloys are suitable for superconducting shielding devices for high fields. (auth)

49287 PHASE COHERENCE AND NOISE RESISTIVITY IN WEAKLY CONNECTED GRANULAR SUPERCONDUCTORS. Pellan, P.; Dousselin, G.; Cortes, H.; Rosenblatt, J. (Institut National des Sciences Appliquees, Rennes, France). Solid State Commun.; 11: No. 3, 427-31(1 Aug 1972).

The order parameter in an assembly of superconducting grains may be represented by a set of vectors in the complex plane. These vectors achieve ordering through a phase transition between "paracoherent" and coherent states once Josephson coupling is established between grains. The equations of phase motion are formally similar to those of a single junction with a modified temperature dependence of the Josephson supercurrent. Resistivity measurements on bulk granular superconductors support this conclusion. (auth)

49288 SELF CONSISTENT THEORY OF FLUCTUATIONS NEAR D-DIMENSIONAL SUPERCONDUCTING PHASE TRANSITIONS. Grossmann, S.; Richter, P. H.; Wissel, C. (Univ., Marburg, Ger.). Solid State Commun.; 11: No. 3, 433-6(1 Aug 1972).

Nonlinear fluctuation contributions in the vicinity of the transition temperature for D-dimensional superconductors (D = 0...3) are treated in a self-consistent Hartree approximation to the Ginzburg–Landau free energy. The results concern specific heat, correlation length, and the effect of a magnetic field on the specific heat (for D = 2). (auth)

49289 OBSERVATION OF ELECTRON SPIN RESONANCE IN A TYPE-II SUPERCONDUCTOR. Al'tshuler, T. S.; Garifullin, I. A.; Kharakhash'yan, E. G. (Physical-Technical Inst., Kazan). Sov. Phys.-Solid State (Engl. Transl.): 14: No. 1, 213-14(Jul 1972).

Translated from Fiz. Tverd. Tela; 14: No. 1, 263-4(Jan 1972).

The results are reported of preliminary experiments in which the absorption associated with the electron paramagnetic resonance of localized spins in a superconducting metal was observed for the first time. The sample investigated was an intermetallic compound La_3In with a small admixture of Gd which replaced La isomorphously. The composition of Gd was 0.25 at. %. The measurements were carried out at 4.2°K employing a standard modulation-type rf spectrometer with cryogenic equipment. The superconducting transition occurred at ~6°K, indicating that the resonance value of the static magnetic field H_0 was above the upper critical field H_{c2} and, therefore, the observed ESR signal represented a mixed normal—superconducting state. (M.H.R.)

49290 INTERACTION BETWEEN CHARGES AND LIBRATIONAL EXCITATIONS IN SOLID METAL—AMMONIA SOLUTIONS. Slusarev, V. A.; Burakhovich, I. A. (Physical-Technical Inst. of Low Temperatures, Kharkov). Phys. Status Solidi (a); 12: No. 1, K27-9(16 Jul 1972).

The observed superconductivity of quickly frozen solutions of sodium in ammonia may be explained if the Na atoms are gathered into Cottrell clouds along dislocations. The anomalous superconducting transition temperature is due to the interaction between charges and librational excitations in solid NH_3. The libron-induced interelectron is calculated. The effective attraction and the Fermi surface density of states are increased when there are lines of metallic sodium in the samples. As the lines are quasi-one-dimensional systems, the superconducting long-range order is destroyed by fluctuations, and the Meissner effect is absent. (D.L.C.)

49291 EXTENSION OF ELIASHBERG'S THEORY TO TYPE-II SUPERCONDUCTORS. Teichler, H. (Univ., Stuttgart). Phys. Lett.; 40A: No. 5, 429-31(14 Aug 1972).

Eliashberg's theory is extended to Type-II superconductors in such a way that band-structure effects and anisotropies of the phonon-induced electron—electron interaction are included. Thermodynamic potentials for the superconducting system are presented. (auth)

49292 SUPERCONDUCTIVITY IN TIN—GROUP V^a TRICHALCOGENIDES. Van Maaren, M. H. (Phillips Research Labs., Eindhoven, Netherlands). Phys. Lett.; 40A: No. 5, 353-4 (14 Aug 1972).

Superconductivity was found for the tetragonal compounds $SnNbS_3$, $SnTaS_3$, and $SnNbSe_3$ at 2.75, 2.90, and 3.02°K, respectively. Crystallographic data and results of low-temperature specific-heat measurements are reported. (auth)

49293 ALUMINUM STABILIZED SUPERCONDUCTOR AND MAGNET. Nomura, Harehiko; Obata, Minoru. Denki Shikensho Iho; 36: No. 3, 220-38(1972). (In Japanese).

Techniques of aluminum stabilization were studied with the aim of getting better stabilization of the characteristics of a given superconducting material and a more compact and lighter magnet of higher current density. Consequently, a magnet was constructed that has, in comparison with ordinary copper-clad superconducting magnets, 1/2 the volume, 1/4 the weight, twice the packing factor and current density, 1/20 to 1/10 in thickness of the insulator, and shorter in cooling time. Special care was taken in making the superconductor have a good contact with high-purity aluminum because of difficulty in co-processing the aluminum and superconductor into wire, owing to the difference between the two in hardness. The overall current density in the winding was 1.8×10^4 A/cm^2 at the field of 50 kG. The solenoid can have extra currents up to 5 A exceeding over the critical value, and is found to have a resistive state in every layer because of the high thermal conductivity of aluminum and the Al_2O_3 insulator, which means that the magnet constructed is self-protective, as the stored magnetic energy diffuses in the coil and does not melt down the wire locally. (auth)

49294 ELECTRONIC STRUCTURE OF SUPERCONDUCTING Nb—Ti SYSTEM. Sukharevskii, V. Ya.; Shchetkin, I. S.; Fal'ko, I. I. (Physical-Technical Inst., Kharkov). Ukr. Fiz. Zh. (Russ. Ed.); 17: No. 4, 585-91(Apr 1972). (In Russian).

The results of the data processing on heat capacity for solid solutions of the superconducting Nb—Ti system, using the model of two partially crossed bands, are presented. The state density in s and d bands of the system was evaluated by means of two independent methods. A clear correlation is found between gap relations Δ^d/Δ^s (obtained earlier), relations of the state densities N^d/N^s, and transition temperatures T_c for all the alloys studied. The jump disturbance in the superconducting properties for the compound with 75 at.% Ti is discussed. It is suggested that the anomaly in the behavior of these characteristics is due to decay of β-solid solution with the concentration mentioned. (auth)

Equipment and Devices

Refer also to abstracts 48125, 48157, 48498, 48504, and 49745.

49295 (ANL/HEP—6818) STATE-OF-THE-ART: SUPERCONDUCTING MAGNETS. Bergmann, Wilfried H. (Argonne National Lab., Ill.). Sep 1968. 32p. Dep. NTIS.

An attempt is made not only to evaluate the present state-of-the-art of superconducting magnets, but also to assess their potential contribution towards high-energy physics experimentation in the 100 BeV range. What magnet technology has to offer today is sketched briefly. Against this background, the present state of superconducting magnets is outlined. Some conclusions are drawn from the present problems about the directions in which to proceed for future developments. (M.H.R.)

49296 (KFK-EXT—3/72-2) ON MAGNETIC-THERMAL BREAKDOWN IN SUPERCONDUCTING RF CAVITIES. Halbritter, J. (Kernforschungszentrum, Karlsruhe (West Germany). Institut fuer Experimentelle Kernphysik). Mar 1972. 15p. Dep. NTIS (U. S. Sales Only).

Whereas in normal conducting cavities the rf field strengths are limited by discharges due to high electric fields, in superconducting cavities the actual limitation is an rf breakdown related to the magnetic field and the low-breakdown fields observed (≈200 G) are a severe drawback for some practical applications. This new type of breakdown is due to an rf absorption strongly increasing with temperature, especially near the phase transition from the superconducting to the normal conducting state. As in all thermodynamic phase transitions of first order, the breakdown is initiated by nucleation of normal conducting regions (≈coherence length). Therefore, it will be more difficult to reach rf fields near $H_c(T)$ in superconductors with a coherence length short compared to the penetration depth, e.g., Nb, than, e.g., in In, Sn, and Pb. This model can explain the observed dependencies of H_{crit} on material parameters and temperature, which shows that the thermal conductivity does not define H_{crit}. (auth)

49297 (KFK-EXT—3/72-3) ON REAL NIOBIUM SURFACES FOR SUPERCONDUCTING RF CAVITIES. Halbritter, J. (Kernforschungszentrum, Karlsruhe (West Germany). Institut fuer Experimentelle Kernphysik). Mar 1972. 23p. Dep. NTIS (U. S. Sales Only).

The last years have shown that massive niobium is the most promising candidate in the field of superconducting rf cavities. For example, in niobium cavities rf field strengths of $H_{crit} \simeq 10^3$ G at surface resistance of $R \simeq 10^{-8}\,\Omega$ have been observed. But, also, in similarly prepared cavities, worse results have been measured—results that are even inferior to values obtained in lead—plated cavities. The reasons for these discrepancies are surface effects, which are discussed and related to chemical and physical properties of Nb, of Nb with impurities, and of niobium oxides. (auth)

49298 CRYOSTAT FOR INVESTIGATING THE ABSORPTION OF ULTRASOUND IN SOLIDS AT TEMPERATURES DOWN TO 0.32°K. Shepelev, A. G. (Physical-Technical Inst., Kharkov). Instrum. Exp. Tech. (USSR) (Engl. Transl.); 14: No. 5, 1544-7 (1971).

Translated from Prib. Tekh. Eksp.; 14: No. 5, 237-40(1971).

A unit for ultrasonic investigations of massive solids in the temperature range from 0.32 to 2.2°K is described in which up to 20 to 30 liters of gaseous ^3He may be used (under normal conditions). The minimum temperature of ~0.3°K, which is obtained by absorptive evacuation of ^3He vapors, may be maintained in a volume of 35 cm^3 for at least 7 h. This temperature was obtained by increasing the flow cross section of the evacuation pipelines for a thermal influx of $\sim 10^{-3}$ W. The temperature range 4.2 to 0.9°K is covered when ^4He is used. (1 figure) (auth)

49299 SUPERCONDUCTING SOLENOID HAVING A FIELD OF UP TO 90 kOe WITH A TRANSVERSE WORKING GAP. Goridov, S. I.; Lazareva, L. S.; Morgun, V. N. Instrum. Exp. Tech. (USSR) (Engl. Transl.); 14: No. 5, 1548-50(1971).

Translated from Prib. Tekh. Eksp.; 14: No. 5, 240-1(1971).

A superconducting solenoid having a transverse working gap and a winding made of Nb + Ti wire is described. The solenoid consists of two coils placed close together on a single axis, each of which creates a maximum field ~64 kOe at $T = 4.2^\circ$K. In the center of the transverse gap the field for $T = 4.2^\circ$K is 55.6 kOe, while for $T = 2^\circ$K it is 67 kOe; when concentrators made of dysprosium are used, the field reaches 89 kOe ($T = 2^\circ$K) in a gap of 2 mm. (3 figures, 2 tables) (auth)

49300 STABLE SUPERCONDUCTING POINT CONTACT. Nad, F. Ya. (Inst. of Radio Engineering and Electronics, Moscow). Instrum. Exp. Tech. (USSR) (Engl. Transl.); 14: No. 6, 1794-5 (1971).

Translated from Prib. Tekh. Eksp.; 14: No. 6, 179-80(1971).

A method is described for creating a stable superconducting point contact with the properties of a Josephson junction. The construction of a special mount is considered whose deformation can be used to create a contact between points fastened to it and a flat electrode. The parameters of the resulting contacts are presented, and data are given on their stability. (1 figure) (auth)

49301 MULTIFILAMENT COMPOSITES. Bronca, G.; Pouillange, J. P.; Prost, G. (CEN de Saclay, Gif-sur-Yvette, France). Rev. Phys. Appl.; 6: No. 4, 527-30(Dec 1971). (In French).

From second conference on superconducting materials and the applications of superconductivity; Aussois, France (24 Mar 1971). See CONF-710352.

The electromagnetic behavior of the multifilamentary composites is complicated. The superconducting filaments are not insulated, thus circulating current loops are closed in half-a-twist pitch through superconducting filaments and matrix metal; the losses due to these currents are estimated in the case where there is no transport current. The twist operation is not a perfect transposition of the composite self-field; self-field effects on the current distribution in the composite and the losses are indicated. Due to the twist the filaments are not everywhere perpendicular to the magnetic field. Experimental results concerning the degradation and the losses of small coils made from several multifilamentary composites are reviewed. (auth)

49302 PHYSICS OF SOME SUPERCONDUCTING DEVICES. Giaever, Ivar (General Electric Research and Development Center, Schenectady, N. Y.). J. Vac. Sci. Technol.; 9: No. 4, 1159-65(1972).

Some of the more common superconductive devices suitable for computer applications are reviewed briefly. None of the devices have emerged beyond the laboratory stage, mainly because of the low-temperature requirements. Because of the increased sophistication in the integrated semiconducting technology, it appears that superconducting devices can only succeed when their function is unique; for example, the ac Josephson effect is under serious consideration as a tool to determine the international voltage standard. (auth)

49303 50-kG HOMOGENEOUS SUPERCONDUCTING SOLENOID WITH LOW DEGRADATION. Jelinek, Josef; Dolezal, Ivan (Czechoslovak Acad. Sci., Brno). Cesk. Cas. Fys.; 22: No. 4, 331-8(1972). (In Czech).

To verify the superconductor parameters, the methods of calculation, design and technology of the solenoid winding, a reduced model (of 20 mm ID) of the homogeneous solenoid of an NMR spectrometer was built of a length of the Niomax S 25/40 superconductor. To facilitate manipulation of the solenoid, the magnetic field was first mapped in liquid nitrogen at 0.5 A passing through the copper sheath of the superconductor. This was followed by an examination of the field homogeneity and the determination of the critical current at $B = 50$ kG; the value obtained, $I_k = 57.5$ A corresponds to 7 to 10% degradation. The magnetic field homogeneity measured with a Hall probe is better than $5 \times 10^{-5}\ B_k$ in the region of ±15 mm from the solenoid center. The experience gained in the study was used in the design of a 60-kG homogeneous solenoid with an ID of 60 mm. (auth)

PHYSICS (NUCLEAR)

49304 (ANU-P–553) EXACT LEAST SQUARES FITTING OF GAMMA-RAY ANGULAR DISTRIBUTIONS WITH SEVERAL RESTRICTED LINEAR PARAMETERS. Bell, R. A. I. (Australian National Univ., Canberra. Dept. of Nuclear Physics). 1972. 11p. Dep. NTIS (U. S. Sales Only).

A method is described for least squares fitting of gamma ray angular distributions to theoretical formulae in which a number of linear parameters vary freely between defined limits. (These linear parameters correspond to the relative populations of the initial nucleus' magnetic substates.) The method is readily programmed for a small computer. (auth) (Australia)

49305 (BMBW-FBK–72-7) ANNUAL REPORT, 1970. (Technische Universitaet, Munich (West Germany)). May 1972. 138p. (In German). Dep. NTIS (U. S. Sales Only).

The first chapter is concerned with nuclear physics, first with nuclear spectroscopy experiments and then with cross-section measurements for slow and fast neutrons and excitation functions for p-induced reactions. The second chapter reports results from nuclear solid state physics: experiments with ultracold neutrons, measurements of Debye–Waller-factor, inelastic spinflip-scattering, spin-diffusion constant and light emission after nuclear decay and investigations of the effects of low temperature irradiation on metals and several theoretical works are described. The third chapter gives new apparative developments: 1.5 Å neutron guide tube, neutron time of flight diffractometer, resonance scatterer inside the tangential channel and thermal column at the FRM, assembly of a Ge(Li) – Ge(Li)-detector coincidence arrangement and a transfer cryostat, development of a supraconducting DC-amplifier and a Michelson-spectrometer; finally about the setting-up of a high resolution magnetic spectrograph (Q3D) and a new energy measuring and control system at the tandem accelerator. (auth)

49306 (NP–19337) PROGRESS REPORT FOR 1971. Rudstam, Goesta (ed.) (Forskningsradens Laboratorium, Studsvik (Sweden)). 1972. 62p. (LF–36). Dep. NTIS (U. S. Sales Only).

This report summarizes the projects carried out by the research groups at the Swedish Research Councils' Laboratory in the year 1971. The following subjects are dealt with: nuclear structure, nuclear spectroscopy, neutron diffraction, nuclear chemistry, radiation chemistry, and nuclear medicine. (G.N.) (Sweden)

49307 (ORO–2408-49) STUDIES OF NUCLEAR PROCESSES. Progress Report, September 1, 1971–August 31, 1972. Clegg, T. B.; Ludwig, E. J.; Merzbacher, Eugen; Shafroth, S. M.; Thompson, W. J. (North Carolina Univ., Chapel Hill). Contract AT(40-1)-2408. 23p. Dep. NTIS.

The studies of nuclear processes conducted by the Chapel Hill group affiliated with the Triangle Universities Nuclear Laboratory (TUNL) have continued to emphasize the following topics: I. Polarized Proton Beam Experiments; II. Polarized Deuteron Experiments; III. Nuclear Reaction and Scattering; IV. Channeling Experiments; V. Atomic Effects in Nuclear Bombardment; VI. Ion Source Development and Other Instrumentation; VII. Nuclear Structure and Reaction Theory; VIII. Computer Programming for Nuclear Theory and Reaction Data Analysis. The Cyclo Graaff at TUNL and the 4-MeV Van de Graaff accelerator were the primary sources of particle beams. Computations were carried out on the computer at TUNL and at the Triangle Universities Computation Center (TUCC). The research program has led to an enhanced understanding of the spin dependence of nuclear interactions revealed in experiments with polarized beams. Violent collisions between charged particles and complex atoms, leading to inner shell ionization, were studied in detail over a broad energy range. New and improved methods for producing polarized nuclear particles were investigated, and development of new sources was begun. (auth)

49308 GRAPHICAL REPRESENTATION FOR γ-RAY LINEAR POLARIZATION COEFFICIENTS. Green, P. W.; Sheppard, D. W. (Univ. of Alberta, Edmonton). Nucl. Instrum. Methods; 103: No. 1, 109-12(1972).

A graphical method is presented for rapid determination of the possible values of mixing ratio and spin ($J \leqq 10$) from the measurement of a γ-ray linear polarization correlation. (auth)

49309 DIRECTION CORRELATION COEFFICIENTS IN COMPOUND NUCLEAR REACTIONS. Tepel, J. W.; Green, P. W.; Robertson, B. C.; Sheppard, D. M. (Atomic Energy Board, Pelindaba, S. A.). Nucl. Instrum. Methods; 103: No. 1, 171-3 (1972).

In a previous article (P. W. Green et al., Nucl. Instr. and Meth., 98(1972)45) it was assumed that the magnetic substates of a state J_1 following a (p,n) reaction are populated equally up to a value $m_{max} = J(\text{target}) + 1$ and not at all for $m_{max} < |m| \leq J_1$. It is argued in this note that such an assumption does not lead to realistic values of the statistical tensor elements or of the direction correlation coefficients of the subsequent γ-decay.

A reply is made by Green et al. in which they uphold their original approximation. (auth)

Neutron Interactions with Matter

Refer also to abstracts 49355, 49651–49654, 49656–49659, 49724, and 49729.

49310 (AI-AEC–13024) U3R: A CODE TO CALCULATE UNRESOLVED RESONANCE CROSS SECTION PROBABILITY TABLES. Otter, J. M.; Lewis, R. C.; Levitt, L. B. (Atomics International, Canoga Park, Calif.). 31 Jul 1972. Contract AT-(04-3)-824. 53p. Dep. NTIS.

The U3R code is described in detail. This code generates probability tables for the representation of unresolved neutron resonance cross sections in calculations using pointwise data. Methods using the tables have greatly reduced computer storage and/or running time in Monte Carlo calculations. The theory is summarized, input and output formats described, and a sample case included. Results of tests in an integral transport theory slowing down calculation are shown. (auth)

49311 (HEDL-TME–72-99) ANALYSIS OF ERRORS IN COMPUTED INTEGRAL CROSS SECTION DUE TO FLUCTUATING RESONANCE PARAMETERS. Schmittroth, F. (Hanford Engineering Development Lab., Richland, Wash.). Jul 1972. Contract AT(45-1)-2170. 32p. Dep. NTIS.

Neutron cross sections used in reactor theory are normally described by resonances at low energies and by a smoothly varying function, which is an average over many resonances, at higher energies. The use of average (unresolved) cross sections to compute integral cross sections is justified only if many resonances are included so that statistical fluctuations are small. Quantitative formulas are given to find the effect of these fluctuations and are applied to some examples to illustrate their use. (auth)

49312 (JAERI–1220) COMPUTATIONAL METHOD OF THERMAL NEUTRON SCATTERING KERNELS FOR HIGH TEMPERATURE CRYSTALS. Nakahara, Yasuaki; Kadotani, Hiroyuki (Japan Atomic Energy Research Inst., Tokyo). 9 Dec 1971. 25p. Dep. NTIS (U. S. Sales Only).

An efficient treatment of thermal neutron scattering kernels for high temperature crystals has been established and a new computer code HIKER based on the treatment has been developed. Characteristic points in the treatment which are important for taking the high temperature characteristics of crystals into consideration are the following two approximations: (1) The Debye model is used for the low frequency part of the frequency distribution of crystal lattice vibrations. This makes it possible to perform the analytical computation of the scattering law or the dynamical structure factor S_1 (κ, ϵ) for the low frequency lattice modes: (2) The Doppler approximation is used when the Debye–Waller factor, for the high frequency part of the frequency distribution, exceeds a certain limit (above which a good convergence of Edgeworth series is violated). When the Debye–Waller factor is below the limit, the scattering law S_2 (κ, ϵ) for the high frequency lattice modes is computed by the phonon expansion and Edgeworth series methods as usual. The total scattering law S (κ, ϵ) is obtained by convolution of the two partial scattering laws for the low and high frequency lattice modes. The scattering kernel σ (E_0, E) is obtained from S (κ, ϵ) by the interpolation over (κ, ϵ) and the Gaussian integration over the scattering angle. Characteristics of the code HIKER and guides for users are given. Results of calculation for $ZrH_{1.5}$ at 1000°C are also illustrated. The efficiency and accuracy of the method are discussed in comparison with the conventional method. (auth)

49313 (KFK–1576) NUSYS-PHASES 41501–41505. EQUIVALENT APPROXIMATION OF THE STEP FUNCTION AND ITS USE IN NUCLEAR CALCULATIONS (ITERATIVE REMO PROCEDURE). Boehnel, K.; Stein, E.; Thiem, D.; Willerding, G. (Kernforschungszentrum, Karlsruhe (West Germany). Institut fuer Neutronenphysik und Reaktortechnik). Mar 1972. 35p. (In German). Dep. NTIS (U. S. Sales Only).

The so-called REMO-Method is used in the Karlsruhe Nuclear Code System NUSYS for the correction of the effective elastic removal multigroup constants, which are normally determined by the well-known σ_0-concept. A suitable many-group (e.g., 208 groups) collision density is needed as weighting function to generate the improved elastic removal group constants. The multigroup (e.g., 26 groups) collision density obtained when applying the improved group constants can be used for a further iterative improvement of the multigroup elastic removal constants and the corresponding neutron spectrum. To provide a new weighting function one has to modify the multigroup collision density in an appropriate manner to obtain a function with a many-group structure. This is performed by smoothing the multigroup collision density and rearranging the result into the many-group scheme. The present paper describes several NUSYS-Codes developed for this purpose and gives an instruction to the user for the application of the iterative REMO-Method. (auth)

49314 (LA-4785) RAYMATH, A COMPUTER LANGUAGE FOR THE REDUCTION OF DATA FROM NEUTRON CROSS-SECTION EXPERIMENTS. Harlow, Marvin V. Jr.; Ferrell, Kenneth D.; Phillips, Anne N.; Wigglesworth, Rita M. (Los Alamos Scientific Lab., N. Mex.). Jul 1972. Contract W-7405-eng-36. 150p. Dep. NTIS.

RAYMATH is a problem-oriented computer language for reduction of data residing in one-dimensional arrays. It consists of 52 modular instructions designed to manipulate 6 arrays and 32 constants. Array mathematics, special-purpose operations, and extensive plotting may be achieved readily. Free-input format permits problems to be coded and submitted through a remote-keyboard terminal. The subroutine packages for the modular instructions, as well as the language translator, are written in FORTRAN IV for a CDC-6600 computer. FORTRAN IV is a proper subset of RAYMATH. (auth)

49315 (LA-4800) TIMEX: A TIME-DEPENDENT EXPLICIT DISCRETE ORDINATES PROGRAM FOR THE SOLUTION OF MULTIGROUP TRANSPORT EQUATIONS. Reed, Wm. H. (Los Alamos Scientific Lab., N. Mex.). Jul 1972. Contract W-7405-eng-36. 51p. Dep. NTIS.

A finite difference technique is given for solving the one-dimensional (slab, cylindrical, spherical), time-dependent, multigroup transport equations with anisotropic scattering. This technique is unconditionally stable so that arbitrarily large time steps can be taken. Because no iteration is performed the method is exceptionally fast in terms of computing time per time step. Two acceleration methods designed to improve the accuracy of the finite difference technique are presented. Both acceleration methods are available in the TIMEX code, which uses the finite difference technique to solve the time-dependent transport equation in one space dimension. Detailed input and usage instructions for TIMEX are given. A sample problem is presented. (auth)

49316 (NP-19368) CEKMECE NUCLEAR RESEARCH AND CENTRAL EDUCATION 1970 PROGRESS REPORT. (Cekmece Nuclear Research Center, Istanbul (Turkey)). 1972. 79p. (In Turkish). Dep. NTIS (U. S. Sales Only).

Research carried out in physics (plasma, nuclear solid-state, and electronics), chemistry, radiobiology, and nuclear engineering is reviewed. Reactor operations, health physics, radioisotope production, and electronics are discussed. Technical services, control and upkeep of the physical plant, documentation and publication, and educational and administrative activities are included. (R.W.R.)

49317 (ORNL-RSIC-33, pp 159-69) CORRELATED SAMPLING AND ITS IMPLEMENTATION IN THE SAMCEP CODE. Steinberg, H. A. (Mathematical Applications Group, Inc., White Plains, N. Y.). May 1972.

From Radiation Shielding Information Center seminar-workshop; Oak Ridge, Tenn. (15 Nov 1971).

The SAMCEP code system was developed as a tool to aid cross section evaluation by using correlated sampling as a means of determining the effects of small changes in cross sections upon neutron transport. In order to maximize the confidence in correlated calculations, the Monte Carlo code makes use of the envelope of individual sampling function to define the sampling functions for the correlated transport computations. (M.H.R.)

49318 (ORNL-RSIC-33, pp 171-96) CROSS SECTION SENSITIVITY STUDIES USING THE SAMCEP CODE. Banks, Norman E. (Ballistic Research Labs., Aberdeen Proving Ground, Md.). May 1972.

From Radiation Shielding Information Center seminar-workshop; Oak Ridge, Tenn. (15 Nov 1971).

A series of SAMCEP calculations were carried out for nitrogen and for air, in order to make comparisons with other results, to check the code for errors, and to investigate its efficiency. The results are presented and discussed. (M.H.R.)

49319 (ORNL-RSIC-33, pp 299-321) LAST-COLLISION MODEL OF THE AIR/GROUND INTERFACE EFFECT ON FAST-NEUTRON ANGLE DISTRIBUTIONS. French, R. L.; Mooney, L. G. (Radiation Research Associates, Inc., Fort Worth, Tex.). May 1972.

From Radiation Shielding Information Center seminar-workshop; Oak Ridge, Tenn. (15 Nov 1971).

The last-collision method for computing the air-ground interface effect on scattered neutron intensity was extended to give the effect on the intensity within individual polar angle groups at a detector near the ground. The method yields angle-dependent perturbation factors which may be used to adjust infinite-air angle distributions to account for the presence of an air-ground interface, or to adjust angle distributions from one detector height to another. To determine the factors, a uniform scattering distribution in the air about the detector is assumed, and the fractional contribution from each last-collision center in the air is calculated. In addition, the fraction scattered directly to the detector from the ground surface is calculated using a simplified albedo model. An evaluation of the angle-dependent last-collision model indicated that the results of discrete ordinate calculations for infinite air could be modified to give relative polar angle distributions of the scattered neutron dose near the air-ground interface within 10 to 20% of those calculated directly for the air-over-ground case by the discrete ordinate method. (auth)

49320 (ORNL-RSIC-33, pp 323-40) TIME-DEPENDENT, TWO-DIMENSIONAL CALCULATION OF ENERGY DEPOSITION IN AIR DUE TO NEUTRONS FROM A HIGH-ENERGY SOURCE. Roach, William H. (Los Alamos Scientific Lab., N. Mex.). May 1972.

From Radiation Shielding Information Center seminar-workshop; Oak Ridge, Tenn. (15 Nov 1971).

Results from a time-dependent, two-dimensional calculation of energy deposition in air due to neutrons from a high-energy source at 26-km altitude are shown. Brief descriptive statements are given regarding the calculational method, neutron cross sections, and interpretation of results. (auth)

49321 (ORNL-RSIC-33, pp 361-400) GENERAL METHODS FOR CALCULATING THE EFFECT OF SOURCE ANISOTROPY. Woolson, W. A.; Coleman, W. A. (Science Applications, Inc., La Jolla, Calif. (USA)). May 1972.

From Radiation Shielding Information Center seminar-workshop; Oak Ridge, Tenn. (15 Nov 1971).

Methods are developed which would permit the calculation of radiation fields resulting from a broad class of source anisotropies important in weapon output. Two such methods are presented and compared for the transport of fast neutrons in infinite homogeneous air. One method, which can be used in certain air over ground configurations, uses Monte Carlo to calculate source cosine moments of the fluence. The other method, limited to infinite homogeneous air, uses adjoint one-dimensional discretes ordinates to calculate the angular dependent importance of the source to the fluence at radially dependent detectors. The Monte Carlo method and the discrete ordinates method were used to calculate the energy dependent free field fluence of neutrons for 13 source energy groups from .1 MeV to 15 MeV for generalized anisotropic sources. The MORSE code was used for the Monte Carlo calculations. The discrete ordinates calculations were performed with the ANISN code. Comparisons of the energy-dependent fluence and silicon response for the two methods are presented for 14 MeV and fission sources with three types of source anisotropy. (M.H.R.)

49322 (ORNL-RSIC-33, pp 401-8) TWO-DIMENSIONAL AIR TRANSPORT FROM A POINT, ANISOTROPIC SOURCE. Lathrop, K. D. (Los Alamos Scientific Lab., N. Mex.). May 1972.

From Radiation Shielding Information Center seminar-workshop; Oak Ridge, Tenn. (15 Nov 1971).

The calculation of the angular flux in air from a given anisotropic point source of neutrons is described here. These calculations were performed with the TWOTRAN SPHERE code suitably modified to include an analytical calculation of the uncollided flux. The calculated total flux was spot checked for accuracy against results from a Monte Carlo calculation. (M.H.R.)

49323 (RFP-1836) THEORETICAL AND EXPERIMENTAL EVALUATION OF THE DISTRIBUTION OF THERMALIZED 15-MeV NEUTRONS IN A FINITE WATER MODERATOR. Vasilik, Dennis G.; Murri, Richard L.; Fisher, George P. (Dow Chemical Co., Golden, Colo. Rocky Flats Div.). 20 Jun 1972. Contract AT-(29-1)-1106. 10p. Dep. NTIS.

The energy-dependent diffusion equation was used to describe the spatial distribution of moderated neutrons. One of the most expedient ways of solving this equation is the multigroup method. The theory of this method is discussed and a general solution of the multigroup equation is derived. An explanation of the methods used to determine the values of the parameters needed in the solution of the multigroup equation is also presented. The multigroup method is then applied to the problem of the thermalization of neutrons from a point source of 15 MeV neutrons in a finite water moderator. In particular, an eight-group approximation is compared to an experimentally measured thermal neutron flux distribution in the water moderator. The experimental data verify the theoretical results. A theoretical slowing-down age of 151.7 cm^2 is calculated for 15 MeV neutrons which have been slowed down below 0.55 eV. (auth)

49324 (SC-DC-721236) CONVERSION OF NEUTRON SPECTRA TO THEIR 14 MeV EQUIVALENCE. McKenzie, J. M.; Witt, L. J. (Sandia Labs., Albuquerque, N. Mex.). Jul 1972. 22p. (CONF-720707-6). Dep. NTIS.

From Annual conference on nuclear and space radiation effects; Seattle, WA. (24 Jul 1972).

An experimental method is given for the conversion of a neutron threat spectrum to a 14 MeV neutron equivalence fluence by least squares fitting it with four known spectra. The procedure gives both the magnitude and variance of the equivalence. Device or system testing can be conducted with damaging neutrons of any spectral distribution provided the 14 MeV equivalence of the spectrum has been measured. (auth)

49325 INTEGRAL TRANSFORM METHOD FOR TWO AND THREE DIMENSIONAL NEUTRON TRANSPORT PROBLEMS. Sahni, D. C. (Bhabha Atomic Research Centre, Bombay). J. Nucl. Energy; 26: No. 7, 367-78(Jul 1972).

A method was developed to solve neutron transport problems in two- and three-dimensional systems. The method uses the Fourier transform of transport integral equation, and is an extension of j_N-method of Asaoka. It is also equivalent to the usual variational method using expansion of neutron flux in powers of the co-ordinates. The use of Fourier transforms, however, allows analytical evaluation of the relevant matrix elements. Numerical results are presented for one-group criticality problems of an infinite rectangular prism and a finite cylinder. (auth)

49326 QUASI-ELASTIC NEUTRON SCATTERING FOR THE INVESTIGATION OF DIFFUSIVE MOTIONS IN SOLIDS AND LIQUIDS. Springer, Tasso (Kernforschungsanlage, Juelich, Ger.). Springer Tracts Mod. Phys.; 64: 1-100(1972).

This book reviews the applications of quasi-elastic scattering of neutrons (translational diffusion of neutrons) in physics and chemistry. After a consideration of the scattering theory and experimental aspects, simple liquids, hydrogen diffusion in metals, rotations of molecules in solids, molecular liquids, and polymers and other complicated systems are discussed in turn. Periodical modes are only treated insofar as they determine the intensity of the quasielastic line. Coherent scattering effects are discussed briefly. Finally, quasi-elastic scattering is compared with other scattering and resonance methods. (201 references) (D.L.C.)

49327 INTEGRAL FLUX CALCULATION AT A POINT. Podlivaev, I. F.; Ruzu, Yu. I. Zh. Vychisl. Mat. i Mat. Fiz.; 12: No. 1, 252-7(1972). (In Russian).

A modification of the Monte-Carlo method was proposed for calculating the integral neutron flux at a point with finite dispersion. Tactical parameters are suggested for minimizing the costs of the calculation. (tr-auth)

49328 MEASUREMENTS OF COLD NEUTRON SPECTRUM IN CONDENSED METHANE. Inoue, Kazuhiko (Hokkaido Univ., Sapporo); Otomo, Noria; Uturo, Masahiko; Fujita, Yosiaki. Hokkaido Daigaku Kogakubu Kenkyu Hokoku; No. 63, 91-7(Mar 1972). (In Japanese).

The measurements of cold neutron spectrum in condensed methane at low temperature between 10°K and boiling point have been carried out using a 25-MeV electron linear accelerator and time-of-flight technique. It is observed that the neutron spectra at boiling and melting points indicate establishment of thermal equilibrium, whereas at 20 and 10°K there exists considerable difference from thermal equilibrium. In addition, it is found that the limiting neutron temperature below which it does not fall, even when the methane temperature drops further, is about 10°K. (auth) (Japan)

49329 INELASTIC SCATTERING OF SLOW NEUTRONS BY LOCALIZED VIBRATIONS OF INTERSTITIAL ATOMS. Dzyub, I. P.; Kochmarskii, V. Z. (Inst. of Theoretical Physics, Kiev). Sov. Phys.-Solid State (Engl. Transl.); 14: No. 1, 1-8(Jul 1972).

Translated from Fiz. Tverd. Tela; 14: No. 1, 3-12(Jan 1972).

The differential cross section for inelastic coherent slow neutron scattering by localized vibrations of interstitial atoms is calculated. It is shown that under certain conditions imposed on the change in the force matrix arising from the impurity, it is possible to reconstruct the force matrix of the perturbation from the angular distribution of neutrons scattered by even localized vibrations. (auth)

49330 CHOICE OF NEUTRON FILTERS IN ACTIVATION ANALYSIS. Rossitto, F.; Terrani, M.; Terrani, S. (CESNEF, Politecnico, Milan). Nucl. Instrum. Methods; 103: No. 1, 77-83 (1972).

Boron, cadmium and composite boron + cadmium filters are considered, and simple expressions useful for the optimal choice of the filter are derived and compared with experimental results. Some problems connected with the irradiation in filtered beams are also pointed out and discussed. (auth)

Nuclear Properties and Reactions, A $\leq$ 5

Refer also to abstracts 48494, 49096, 49348, 49355, and 49377.

49331 (CALT-68-319) PHOTODISINTEGRATION STUDIES OF ^{3}He. Preliminary Results. Heusch, C. A.; Kline, R. V.; McDonald, K. T.; Prescott, C. Y. (California Inst. of Tech., Pasadena). Aug 1971. 10p. (CONF-710816-22). Dep. NTIS.

From International symposium on electron and photon interactions at high energies; Ithaca, N. Y. (23 Aug 1971).

The differential cross section for the ^{3}He(γ,p)d reaction was measured at photon energies of 200 to 500 MeV. Measurements were made at 30 to 150° in 30° steps and at 75° in the COM system. The energies and angles were chosen to investigate the contribution of the Δ(1236) resonance in the S-channel. (J.W.R.)

49332 (CERN-72-13) PROTON TOTAL CROSS SECTIONS ON ^{1}H, ^{2}D, ^{4}He, ^{12}C, AND ^{16}O IN THE ENERGY RANGE 180 TO 560 MeV. Schwaller, P.; Favier, B.; Measday, D. F.; Pepin, M.; Renberg, P. U.; Serre, C. (European Organization for Nuclear Research, Geneva (Switzerland)). 6 Jul 1972. 50p. Dep. NTIS (U. S. Sales Only).

Proton total cross sections on ^{1}H, ^{2}D, ^{4}He, ^{12}C, and ^{16}O have been measured in the energy range 180 to 560 MeV in a high precision transmission experiment with a statistical accuracy of ±0.2%. Random errors are typically ±0.5% for pp data, ±1% for ^{2}D and ^{4}He, and ±(1−3%) for ^{12}C and ^{16}O total cross sections. Systematic errors of ±(0.8−1%) in the ^{1}H and ^{2}D data originate mainly from uncertainties in applying the correct Coulomb-nuclear interference corrections to the measured partial cross sections before extrapolating to the total cross section at zero solid angle. The real parts of the nuclear spin-independent forward scattering amplitudes on ^{4}He, ^{12}C, and ^{16}O were obtained in the same experiment by analyzing the angular dependence of the partial cross sections in the Coulomb-nuclear interference region. Total cross sections are calculated in a Glauber-model approach, and the results are compared to this data. (auth)

49333 (FRNC-TH-183) STUDY OF THE $p + d \rightarrow p + p + n$ THREE NUCLEON REACTION BETWEEN 20 AND 60 MeV IN THE QUASI-ELASTIC SCATTERING REGION. Durand, J. L. (Grenoble Univ. (France)). 1971. 103p. (In French) Dep. NTIS (U. S. Sales Only).

The $p + d \rightarrow p + p + n$ reaction was studied as a function of the incident energy between 20 and 60 MeV. The absolute values of the differential cross sections were measured in such a way as to facilitate the determination of the limits of the simplified models. Quasi-free (p,p) and (p,n) scattering were compared by simultaneously performing the D(p,2p)n and D(p,pn)p experiments. It was demonstrated that it is not possible to take into account the magnitude and the form of the spectra obtained by using the single term of the simple scattering formula to calculate the cross sections. The results are compared with calculations of M. Durand, which take into account the first three terms of the re-scattering formula. The two-body interaction potentials which are in good agreement with experiment are: the Yamaguchi potential for p-n elastic scattering and the Tabakin potential for the (p-p) quasi elastic scattering. (France)

49334 (JINR-E1-6534) PRELIMINARY PHASE SHIFT ANALYSIS FOR π^4He ELASTIC SCATTERING. Falomkin, I. V.; Kulyukin, M. M.; Lyashenko, V. I.; Mihul, A.; Nichitiu, F.; Piragino, G.; Pontecorvo, G.; Shcherbakov, Yu. A. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Nuclear Problems). 1972. 23p. Dep. NTIS (U. S. Sales Only).

In this paper a preliminary phase shift analysis of the π ^{4}He elastic scattering for the energy interval from 24 to 153 MeV is presented. The energy dependence of δ_1, η_1 and the Argand diagrams show resonant behavior for the energy region around 140 MeV. The Δ_{33} resonance in ^{4}He appears not only in the P wave but also in the S and D waves. The results are compared with predictions of the dispersion relations. (auth)

49335 SLOW-NEUTRON SCATTERING CROSS-SECTION FOR METHANOL, ETHANOL, PROPANOL, ISO-PROPANOL, BUTANOL, ETHANEDIOL, AND PROPANETRIOL. Rodrigues, C.; Vinhas, L. A.; Herdade, S. B.; do Amaral, L. Q. (Instituto de Energia Atomica, Sao Paulo, Brazil). J. Nucl. Energy; 26: No. 7, 379-83(Jul 1972).

Slow neutron scattering cross-sections per proton σ_s/H for methanol, ethanol, n-propanol, iso-propanol, n-butanol, ethanediol and propanetriol were measured in the liquid phase, in order to study the freedom of rotational motion of hydrogenous groups. The measurements, at room temperature, were carried out using a curved-slit slow-neutron chopper and time-of-flight spectrometer. The slopes of the cross-section curves as a function of neutron wavelength in the range 4.8 Å to 10.0 Å were derived. The results show the importance of rotational motion of the methyl groups and give evidence of the contribution of methylene groups in the inelastic scattering of slow neutrons. The curve σ_s/H for methanol is compared with the already calculated curve on basis of the Krieger—Nelkin model. (auth)

49336 TOTAL NEUTRON CROSS SECTION OF HYDROGEN IN BINARY SOLUTIONS OF LIQUIDS. Suszkin, A. (Inst. of Physics, Geesthacht, Ger.). Atomkernenergie; 19: No. 4, 325-8(Jul 1972).

An equation is derived which describes the form of dependence of total hydrogen cross section in a binary solution on its concentration. The parameters of the solution, the ratio of total hydrogen cross sections and the ratio of the densities of hydrogen atoms in initial liquids determine the form of this dependence. The results of measurements previously obtained correspond to the values calculated here. (auth)

49337 ANALYSIS OF ^{2}H(n,p)2n REACTION CROSS SECTION BY MEANS OF THE DIAGRAM SUMMATION. Arai, Eiichi (Tokyo Inst. of Tech.). Bull. Tokyo Inst. Technol. (Engl. Ed.); No. 109, 25-32(Mar 1972).

The diagram summation approximation technique was applied to understand the mechanism of ^{2}H(n,p)2n breakup reaction. The triangle diagram was added to the pole diagrams for the calculation of the reaction cross sections. Reasonable agreement was obtained at the neutron and proton energies where an enhancement of the cross section was observed. (auth) (Japan)

49338 SIMULTANEOUS EFFECT OF P-WAVE INTERACTIONS AND TENSOR FORCE ON THE POLARIZATION IN N—d SCATTERING. Doleschall, P. (Central Research Inst. for Physics, Budapest). Phys. Lett.; 40B: No. 4, 443-5(24 Jul 1972).

A three-body calculation is performed at $E_n = 14.1$ MeV for n—d elastic scattering which takes into account the ${}^1S_0$, ${}^3S_1 - {}^3D_1$, ${}^1P_1$, ${}^3P_0$, ${}^3P_1$, and ${}^3P_2$ components of the nucleon—nucleon interaction. Good agreement with experimental data is obtained for the differential cross section and neutron polarization. The deuteron polarizations are also qualitatively reproduced. (auth)

49339 CONVERGENCE OF GENERALIZED SPHERICAL HARMONIC EXPANSIONS IN THE THREE NUCLEON BOUND STATE. Schneider, T. R. (Univ. of Pennsylvania, Philadelphia). Phys. Lett.; 40B: No. 4, 439-42(24 Jul 1972).

Theorems are presented on the rate of convergence of approximate three-nucleon binding energies obtained by expanding the bound-state wave function in a truncated generalized spherical harmonic basis. The rate of convergence is related to the properties of the two-body potential. (auth)

49340 CALCULATION OF THE ^{3}He CHARGE FORM FACTOR WITH THE REID POTENTIAL. McMillan, M. (Univ. of British Columbia, Vancouver). Phys. Lett.; 40B: No. 4, 437-8(24 Jul 1972).

The ^{3}He charge form factor was calculated with the Reid soft-core potential by using an altered Feshbach—Rubinow equivalent two-body method. A minimum near the experimental one is found. (auth)

Nuclear Properties and Reactions, $6 \leq A \leq 19$

Refer also to abstracts 49332, 49392, and 49450.

49341 (ANU-P—550) ^{10}B(^{3}He,PARTICLE) CROSS SECTIONS, AND THE 26, 28, AND 32-MeV STATES OF ^{13}N. Bell, R. A. I.; Graham, I. G.; Thompson, J. V.; Titterton, E. W. (Australian National Univ., Canberra. Dept. of Nuclear Physics). 1972. 25p. Dep. NTIS (U. S. Sales Only).

Absolute differential cross sections have been measured for various ^{10}B(^{3}He, particle) reactions at incident energies from 11 to 19 MeV as follows: p_0, p_1 at 90°, 150°; d_0, d_1, d_2, d_3, $d_{4,5}$ at 150°; α_0, α_1 at 30°, 60°, 90°, 150°. At 150° both the $d_{4,5}$ and α_1 groups showed strong increases in yield near 13.5 MeV, indicative of a 32 MeV resonance in the ^{13}N compound system. The nature of states seen at 26, 28 and 32 MeV excitation in these and other reactions is discussed. (auth) (Australia)

49342 (ANU-P—552) ^{16}O + ^{12}C QUASIMOLECULAR STATES. Nagorcka, B. N.; Newton, J. O. (Australian National Univ., Canberra. Dept. of Nuclear Physics). 1972. 13p. Dep. NTIS (U. S. Sales Only).

Resonances in the total reaction yield of the ^{16}O + ^{12}C reaction cannot be explained in terms of statistical fluctuations and like the ^{12}C + ^{12}C reaction, could be quasimolecular in nature. An attempt was made using the optical model to interpret these quasimolecular resonances as resonances in a potential well and good qualitative agreement with the data was obtained. (auth) (Australia)

49343 (COO—7-622) ISOSPIN-FORBIDDEN AND ALLOWED ^{12}C(d,α)^{10}B CROSS SECTIONS. Smith, H. Vernon Jr. (Wisconsin Univ., Madison). [nd]. Contract AT(11-1)-Gen-7. 45p. Dep. NTIS.

Extensive new data on the isospin-forbidden ^{12}C(d,α_2)^{10}B(1.74) reaction for 7.19 MeV $\leq E_d \leq$ 13.99 MeV are reported. Also, extensive data for the isospin-allowed ^{12}C(d,$\alpha_{0,1,3}$)^{10}B reactions are reported. All channels exhibit resonant behavior indicative of compound nucleus formation. No evidence was found for appreciable direct or semi-direct contribution to the α_2 cross sections. A partial-wave expansion of the α_2 data fixes J^π for a number of (isospin-mixed) ^{14}N compound nuclear levels. The data do not support either Noble's proposed ^{6}Li mechanism or Weller's modification to Noble's proposal. (auth)

49344 (COO—535-666) QUASIELASTIC (p,n) STUDIES AND THE ISOSPIN DEPENDENCE OF NUCLEON—NUCLEUS OPTICAL POTENTIALS. Carlson, J. D.; Lind, D. A.; Zafiratos, C. D. (Colorado Univ., Boulder). 1972. Contract AT(11-1)-535. 102p. Dep. NTIS.

Quasielastic (p,n) differential cross sections have been measured for 29 nuclei at a proton energy of 22.8 MeV in approximately 7.5° steps from 10° to 152°. The targets included ^{9}Be, ^{25,26}Mg, ^{27}Al, ^{31}P, ^{40}Ar, ^{49}Ti, ^{50}Cr, ^{54,56,58}Fe, ^{58,61,62,64}Ni, ^{64}Zn, ^{90,96}Zr, ^{93}Nb, ^{96}Mo, ^{96,104}Ru, ^{115}In, ${}^{117-120}$Sn, ^{165}Ho, and ^{208}Pb. The results have been analyzed with a distorted-wave Born-approximation in terms of the generalized optical model potential due to Lane. A complex isospin interaction was used. Parameter searches were made in which the radial shape of the imaginary surface peaked portion of the interaction was determined along with the overall interaction strength. The radius and diffuseness parameters which specified the shape of the real volume part of the isospin interaction and the ratio of real to imaginary well depths were fixed at values taken from the Becchetti and Greenlees global set of proton optical potentials. The shape of the imaginary surface peaked part of the isospin interaction which gave the best fit to the quasielastic (p,n) data was found to vary systematically with nuclear mass. As the mass of the target nucleus increased, the imaginary interaction form factor became broader and peaked at a progressively smaller radius relative to the radius of the real part of the isospin interaction. The broadening caused the imaginary part of the isospin interaction to have a tail which extended appreciably beyond the real part of the interaction. The best-fit interaction parameters were used to generate self-consistent neutron optical potentials from proton optical potentials as prescribed by the Lane model. Neutron elastic scattering cross sections calculated using these self-consistent potentials were found to be in good agreement with observed neutron scattering data. (auth)

49345 (DESY—72/22) PHOTON INDUCED NUCLEAR REACTIONS ABOVE 1 GeV. I. EXPERIMENTAL. Andersson, G.; Blomqvist, I.; Forkman, B.; Jonsson, G. G.; Jaerund, A.; Kroon, I.; Lindgren, K.; Schroeder, B.; Tesch, K. (Deutsches Elektronen-Synchrotron, Hamburg (West Germany)). May 1972. 53p. Dep. NTIS (U. S. Sales Only).

The yields of the reactions ^{12}C(γ,n)^{11}C, ^{27}Al(γ,π^+)^{27}Mg, ^{27}Al(γ,2pn) ^{24}Na, ^{127}I(γ,ypxn) and ^{197}Au(γ,xn) have been measured in the energy range 1 to 7 GeV by the activation method without chemical separation. The yields and the F/B ratios in the photofission of Au and Pb have been measured by glass plate detectors. From the yields the cross sections have been deduced. Further, the mass distribution from ^{238}U photofission was measured. The results fit well to earlier measurements below 1 GeV. Analysis and discussion of the spallation and fission results are given in a series of consecutive papers. (auth)

49346 (FRNC-TH-188) STUDY OF THE STRUCTURE OF THE ^{12}C NUCLEUS USING 14.1 MeV POLARIZED NEUTRONS. Sene, Raymond (Paris Univ. (France). Faculte des Sciences). 1971. 162p. (In French). Dep. NTIS (U. S. Sales Only).
Thesis.

The angular distributions of the asymmetry in the elastic and inelastic scattering (by excitation of the 2$^+$ level at 4.43 MeV) of 14.1 MeV polarized neutrons by ^{12}C wave were measured. In the analysis of the results of elastic scattering, the usual values of the optical potential parameters enable the cross sections to be fitted and not the polarization. The ALS parameter (surface thickness of the spin—orbit coupling term) which has a dominant effect in the fitting of the polarization was established. The effect of the 15.8 MeV resonance was also established. The first inelastic channel was studied using the coupled channel method, a method which is suitable because of the strong coupling with the elastic channel. A vibrational model was used for the carbon. It was not possible to simultaneously fit the differential cross sections and the asymmetries. When the cross sections are fitted the elastic scattering polarization is no longer considered. The results can not be interpreted in the current state of theoretical studies. (France)

49347 (ITEF-852) CURRENT EXPERIMENTAL DATA AND THE ROLE OF THE MULTI-NUCLEON MECHANISM OF CAPTURE OF SLOW π^--MESONS. Kolybasov, V. M.; Tsepov, V. A. (Vosudarstvennyi Komitet po Ispol'zovaniyu Atomnoi Energii SSSR, Moscow. Institut Teoreticheskoi i Eksperimental'noi Fiziki). 1971. 20p. (In Russian). Dep. NTIS (U. S. Sales Only).

It is shown that the available data on spectra and angular correlations of particles produced from the capture of stopped π^--mesons by C^{12} allow considerable contributions of multinucleon capture mechanisms (in particular the α-particle mechanism). It contradicts the widely held opinion about the dominance of the dinucleon mechanism. The experiments are described which are necessary for the unambiguous determination of the contribution of multinucleon mechanisms. (auth)

49348 (RLO-1388-173) ANNUAL REPORT, 1972. (Washington Univ., Seattle. Nuclear Physics Lab.). Jun 1972. Contract AT(45-1)-1388. 188p. Dep. NTIS.

This report describes research and technical work performed during the year ending April 15, 1972. The information is presented under the following topics: accelerator development, ion source development, instrumentation and research techniques, detector systems, computer systems, reactions and scattering from light nuclei, nuclear astrophysics, beta decay, reactions and scattering (A > 16), reactions produced by polarized proton and deuteron beams, angular correlations, reactions with oxygen and carbon ions, gamma rays, fission and fission isomers, atomic physics, medium energy physics, and research performed by user or visitor groups. (R.W.R.)

49349 PROTON INDUCED REACTIONS ON ^{14}N AND ^{16}O AND THE CREATION OF ELEMENTS LITHIUM, BERYLLIUM, AND BORON. Laumer, Helmut Wolfram. East Lansing, Mich.; Michigan State Univ. (1971). 220p. University Microfilms Order No. 72-16,463.
Thesis.

Measurements of cross sections for production of masses 6 to 11 by proton spallation of ^{14}N and ^{16}O have been carried out. The proton energy range covered was 17 to 42 MeV. These cross sections are indispensable in attacking an unsolved astrophysical problem, the origin of the light elements Li, Be, and B. A number of theories have been proposed, and proton spallation of C, N, and O is found to play a dominant role in several of them. Two methods were employed in the cross-section measurements. For the main body of data collected particle identification was accomplished with a time-of-flight technique based on the narrow proton burst width of the M.S.U. Cyclotron. The particle energy measured with a silicon surface barrier detector and the particle flight time from target to detector yielded mass identification of spallation products. Angular distributions were collected and an integration over angle determined total cross sections. For these measurements gas targets were used, contained in a specially designed gas cell with an exit beam window areal density in the range 50 μg/cm^2 to 130 μg/cm^2. As a check on the time-of-flight technique ^{7}Be and ^{11}C cross sections for proton spallation of ^{14}N were measured at 21.7 MeV using radioactivation followed by γ-ray detection. Gas targets in a gas cell designed for γ-ray counting with the Ge(Li) detector were used. Good agreement was obtained for the cross sections measured by the two methods. A specific model for Li, Be, B production, proton spallation in the surfaces of stars, based on a theory by Bernas, is tested using the newly acquired cross sections. A proton spectrum of the form E$^{-\gamma}$, based on solar flares, is considered. It is found that ^{14}N proton spallation is a large contributor to light element production in spite of the low ^{14}N abundance compared to ^{12}C and ^{16}O. To produce the ratio ^{11}B/^{10}B = 4 as observed in the earth and in meteorites a value of γ low compared to that of proton spectra measured for solar flares is required. The ratio ^{7}Li/^{6}Li = 12.5 as observed for earth and meteorites, on the other hand, can be produced only by proton spectra with improbably high values of γ. A depletion mechanism for ^{6}Li or alternate production mechanisms for ^{7}Li are the more likely explanations for this ratio. (Diss. Abstr. Int., B)

49350 LARGE ISOSPIN-MIXING MATRIX ELEMENT IN ^{12}C. Braithwaite, W. J.; Bussoletti, J. E.; Cecil, F. E.; Garvey, G. T. (Princeton Univ., N. J.). Phys. Rev. Lett.; 29: No. 6, 376-9(7 Aug 1972).

Isospin mixing between the 12.71-MeV, 1$^+$, T = 0 and 15.11-MeV, 1$^+$, T = 1 levels in ^{12}C is measured utilizing two different direct reactions. A consistent value ($\beta^2 \sim 0.01$) is obtained from both the isospin-forbidden reaction ^{12}C(d,d')^{12}C* and the comparison of the yields in the analog reactions ^{13}C(d,t)^{12}C*(15.11 MeV) and ^{13}C(d,^{3}He)^{12}B(0.00 MeV). This mixing implies a charge-dependent matrix element between these two levels of approximately 250 keV. (auth)

49351 HALF-LIFE OF ^{10}Be. Yiou, F.; Raisbeck, G. M. (Centre National de la Recherche Scientifique, Orsay, France). Phys. Rev. Lett.; 29: No. 6, 372-5(7 Aug 1972).

The half-life of ^{10}Be was measured to be (1.5 ± 0.3) × 10^6 yr, a value in significant disagreement with the previously accepted value of (2.7 ± 0.4) × 10^6 yr. Several implications of the revised half-life are discussed. (auth)

49352 SPECTROSCOPY OF ^{15}O BY USE OF THE ^{13}C(^{3}He,n) ^{15}O REACTION. Georgopulos, Peter Demetrios. University Park, Pa.; Pennsylvania State Univ. (1971). 61p. University Microfilms Order No. 72-19,305.
Thesis.

The ^{13}C(^{3}He,n)^{15}O reaction was studied at an incident energy of 6 MeV by employing a 6-meter time-of-flight system. Neutron angular distributions were obtained and fitted with a mixture of both compound-nucleus and DWBA predictions. The two-nucleon coefficients of fractional parentage, which were employed in the direct-reaction theory, were calculated for the first nine states in ^{15}O. It was found that the magnitudes of the direct-reaction cross sections were rather sensitive to changes in these coefficients, while the shapes were generally unaffected. A relative one-hole strength for the two negative-parity states was extracted, while one-particle—two-hole strengths were obtained for the first six positive-parity states. Rejection of a L$_t$ = 1 was made for the positive-parity 10.28-MeV state in ^{15}O; a spin of 5/2 or greater was suggested. A L$_t$ = 2, rather than a L$_t$ = 0, transfer was assigned to the 10.46-MeV state, in concurrence with previous work. (Diss. Abstr. Int., B)

49353 EXCITATION FUNCTION OF (γp) AND (ep) REACTIONS ON ^{12}C AT PHOTON AND ELECTRON ENERGIES UP TO 100 TO 250 MeV. Egiyan, K. Sh.; Bochek, G. L.; Kulibaba, V. M. (Physical-Technical Inst., Erevan). Izv. Akad. Nauk Arm. SSR, Ser. Fiz.; 6: No. 5, 351-6(1971). (In Russian).

The results of excitation function measurements are given for protons produced by photons and electrons with energies of 100 to 250 MeV. In the kinematically allowable region for π photoproduction on nucleons (Ep = 40 MeV, Qp = 30°), the slope of the excitation function curve could be explained by assuming that protons are produced in two processes: γ-quanta absorption by intranuclear quasi-deuterons with subsequent disintegration (the main process) and the photoproduction of π mesons. In the kinematically forbidden region, experimental data are in good agreement with calculations by the quasi-deuteron model. (2 figures) (auth)

49354 OPTICAL MODEL ANALYSIS OF ELASTIC PROTON SCATTERING AT 180 MeV. Ingemarsson, A.; Tibell, G. (Uppsala Univ.). Phys. Scr.; 4: No. 6, 235-42(1971).

Using proton scattering data at about 180 MeV sets of optical potential parameters have been determined for the nuclei ^{9}Be, ^{12}C, ^{27}Al, ^{40}Ca, ^{56}Fe, ^{90}Zr, ^{115}In and ^{197}Au. The experimental data consist of elastic scattering differential cross sections and polarizations as well as total reaction cross sections, except for ^{90}Zr where the reaction cross section is missing. The effects of the finite angular resolution have been taken into account and are shown to be quite important for the polarization, in particular. The analyses have been performed both non-relativistically and semi-relativistically, and the differences appearing in the optical parameters are discussed. (auth) (Sweden)

49355 ANALYTICAL IMPROVEMENT OF NELKIN'S FORMALISM FOR SLOW NEUTRON SCATTERING BY WATER MOLECULES. Stancic, V. Rad. Zavoda Fiz.; 9: 41-51(1971).

An improvement of Nelkin's formalism for treating thermal neutron scattering by water molecules is presented. New expressions are derived for the scattering kernel and the total scattering cross section, in a more convenient integral form. An approximate expression for the scattering kernel is also obtained through use of an expansion of the subintegral function appearing in the new formula. The convenience of the derived formulas is illustrated by the calculation of the scattering kernel and the total scattering cross section, performed on a CDC 3600 computer. Some results of these calculations are presented. (3 tables) (auth)

49356 STRUCTURE OF ^{24}Mg AND ^{28}Si AT HIGH EXCITATION ENERGY. Bromley, D. A.; Chua, L.; Gobbi, A.; (and others) (Yale Univ., New Haven). J. Phys. (Paris), Colloq.; No. 6, 5-16(1971).

From Symposium on heavy ion reactions and many particle excitations; Saclay, France (8 Sep 1971). See CONF-710961.

Excitation functions for the ^{16}O(^{12}C,α)^{24}Mg and ^{12}C(^{16}O,α)^{24}Mg reaction for center-of-mass energies from 18 to 21 MeV show evidence for the importance of α-cluster intermediate structure in both ^{24}Mg and ^{28}Si. Triple coincidence measurements of the resulting 3-body final state also show evidence for ^{12}C + ^{12}C cluster configurations in ^{24}Mg. (France)

49357 ALPHA-PARTICLE PRODUCTION IN HEAVY-ION REACTIONS. Middleton, R.; Garrett, J. D.; Fortune, H. T.; Betts, R. R. (Univ. of Pennsylvania, Philadelphia). J. Phys. (Paris), Colloq.; No. 6, 39-50(1971).

From Symposium on heavy ion reactions and many particle excitations; Saclay, France (8 Sep 1971). See CONF-710961.

Evidence from angular distributions and excitation functions of the ^{12}C(^{12}C,α)^{20}Ne reaction suggests that the 7.20 MeV 0^+, 7.83 MeV 2^+ and 9.03 MeV 4^+ states of ^{20}Ne have the quartet configuration [220]. Remarkably similar evidence from the ^{12}C(^{13}C,α)^{21}Ne reaction suggests that the 3.66 MeV $^3/_2{}^-$ and the 3.89 MeV $^5/_2{}^-$ states may have the configuration of a $1p^1/_2$ neutron weakly coupled to the $[220]_{2+}$ quartet configuration. It appears likely that, in both reactions, the states mentioned are populated by a direct or semi-direct reaction mechanism. (France)

49358 INTERMEDIATE STRUCTURE ASPECTS OF THE REACTION ^{12}C(^{16}O,α)^{24}Mg. Gastebois, J. (CEN de Saclay, Gif-sur-Yvette, France). J. Phys. (Paris), Colloq.; No. 6, 57-62(1971).

From Symposium on heavy ion reactions and many particle excitations; Saclay, France (8 Sep 1971). See Conf-710961.

Gross, correlated structures were observed in the excitation functions of the reaction ^{12}C(^{16}O,α)^{24}Mg, leading to a number of states, up to 22 MeV excitation in ^{24}Mg. The possible occurrence of intermediate states in ^{28}Si, having high spin or a particular structure, quasi molecular, or of several-α-cluster type, is discussed. (France)

49359 ALPHA-TRANSFER REACTIONS. Bethge, K. (Univ., Heidelberg). J. Phys. (Paris), Colloq.; No. 6, 87-90(1971).

From Symposium on heavy ion reactions and many particle excitations; Saclay, France (8 Sep 1971). See CONF-710961.

Negative parity states in ^{15}N and ^{17}O are investigated using alpha transfer experiments. Finite range DWBA calculations were performed to describe the angular distributions leading to negative parity states in ^{17}O. (France)

49360 DETERMINATION OF THE CHARACTERISTICS OF UNSTABLE STATES EXCITED IN THE ^{12}C(^{6}Li,d)^{16}O REACTION BY α–d ANGULAR CORRELATION MEASUREMENTS. Artemov, K. P.; Goldberg, V. Z.; Petrov, I. P.; (and others) (Inst. of Atomic Energy, Moscow). J. Phys. (Paris), Colloq.; No. 6, 125-6 (1971).

From Symposium on heavy ion reactions and many particle excitations; Saclay, France (8 Sep 1971). See CONF-710961.

The d–α coincidence angular correlation in the ^{12}C(^{6}Li,d)^{16}O (6^+, 16.2 MeV) (α,^{12}C$_{gR}$) reaction was studied. It was found to be proportional to the Legendre polynomial of order 6. (France)

49361 PROPERTIES OF HIGHLY-EXCITED STATES IN ^{16}O, POPULATED BY THE ^{12}C(^{6}Li,d) REACTION. Artemov, K. P.; Goldberg, V. Z.; Petrov, I. P.; (and others) (Inst. of Atomic Energy, Moscow). J. Phys. (Paris), Colloq.; No. 6, 127-8(1971).

From Symposium on heavy ion reactions and many particle excitations; Saclay, France (8 Sep 1971). See CONF-710961.

From the study of the ^{12}C(^{6}Li,d)^{16}O (^{12}C$_{gR}$,α) reaction spins and parities were measured for states in ^{16}O at the excitation energies of 14.6(5^-), 16.2(6^+), and 20.8(7^-) MeV. The results obtained show that the ^{12}C(^{6}Li,d)^{16}O reaction populates both the positive and negative parity rotational bands. (France)

49362 (^{6}Li,t) REACTION MECHANISM. Bassani, G. (CEN de Saclay, Gif-sur-Yvette, France); Saunier, N.; Traore, B. M.; Pappalardo, G.; Foti, A. J. Phys. (Paris), Colloq.; No. 6, 133-4(1971).

From Symposium on heavy ion reactions and many particle excitations; Saclay, France (8 Sep 1971). See CONF-710961.

The mechanism of the (^{6}Li,t) reaction was studied in the 20-32 MeV energy range. The results obtained with ^{11}B, ^{12}C, and ^{13}C targets show that the excitation of strong peaks is due to the direct transfer of three nucleons. (France)

49363 ^{16}O LEVELS FROM THE TRANSFER OF THREE AND FOUR NUCLEONS. Bassani, G. (CEN de Saclay, Gif-sur-Yvette, France); Saunier, N.; Traore, B. M.; Pappalardo, G.; Foti, A. J. Phys. (Paris), Colloq.; No. 6, 135-7(1971).

From Symposium on heavy ion reactions and many particle excitations; Saclay, France (8 Sep 1971). See CONF-710961.

Excited levels of ^{16}O were studied using the ^{12}C(^{6}Li,d)^{16}O, ^{12}C(^{7}Li,t)^{16}O, and ^{13}C(^{6}Li,t)^{16}O reactions between 20 and 32 MeV and other results from two-nucleon transfer reactions. (France)

49364 NUCLEON EXCHANGE IN THE SCATTERING OF NUCLEI ON NUCLEI. Bohlen, H. G.; Gebauer, B.; Marquardt, N.;(and others) (Max-Planck-Institut fuer Kernphysik, Heidelberg). J. Phys. (Paris), Colloq.; No. 6, 141-3(1971).

From Symposium on heavy ion reactions and many particle excitations; Saclay, France (8 Sep 1971). See CONF-710961.

The elastic scattering of nuclei on nuclei in the lp-shell involving ^{12}C, ^{13}C, ^{14}C, ^{14}N, ^{15}N, and ^{16}O was measured in the vicinity of the Coulomb barrier. The analysis based on the method of perturbed stationary states gives a consistent description of the pronounced structure in the angular distributions. (France)

49365 ARE THERE α-DOORWAY STATES IN ^{28}Si? Charles, P.; Ballini, R.; Dost, M.; (and others). (CEN de Saclay, Gif-sur-Yevette, France). J. Phys. (Paris), Colloq.; No. 6, 155-6(1971).

From Symposium on heavy ion reactions and many particle excitations; Saclay, France (8 Sep 1971). See CONF-710961.

The excitation functions of the ^{12}C(^{16}O,α)^{24}Mg reaction leading to excited states of ^{24}Mg up to 22 MeV, were measured at 15 and 22.5° (lab. angles) between 41.67 and 56 MeV. Interpretations are given for the correlated structures of one to two MeV width observed. (France)

49366 ELASTIC SCATTERING OF ^{6}Li ON ^{12}C AND ^{16}O. Chuev, V. I.; Davydov, V. V.; Novatskii, B. G.; (and others) (Inst. of Atomic Energy, Moscow). J. Phys. (Paris), Colloq.; No. 6, 161-2(1971).

From Symposium on heavy ion reactions and many particle excitations; Saclay, France (8 Sep 1971). See CONF-710961.

The elastic scattering of ^{6}Li ions on ^{12}C and ^{16}O was measured at an incident energy of 30 MeV. The cross sections have pronounced structure at large angles and strong backward peaking. The results are compared with the optical model calculations. (France)

49367 ELASTIC SCATTERING OF d, ^{3}He, AND α ON ^{6}Li. Chuev, V. I.; Davydov, V. V.; Novatskii, B. G.; (and others) (Inst. of Atomic Energy, Moscow). J. Phys. (Paris), Colloq.; No. 6, 163(1971).

From Symposium on heavy ion reactions and many particle excitations; Saclay, France (8 Sep 1971). See CONF-710961.

The cross sections of the scattering of d, ^{3}He, and α on ^{6}Li are measured at the c.m. energy of about 20 MeV. The (α + ^{6}Li) and (d + ^{6}Li) scatterings show a considerable backward peak contrary to the ^{3}He + ^{6}Li scattering. (France)

49368 ^{12}C(^{6}Li,τ)^{15}N AND ^{12}C(^{6}Li,t)^{15}O REACTIONS. Chuev, V. I.; Davydov, V. V.; Novatskii, G. B.; (and others) (Inst. of Atomic Energy, Moscow). J. Phys. (Paris), Colloq.; No. 6, 165-6(1971).

From Symposium on heavy ion reactions and many particle excitations; Saclay, France (8 Sep 1971). See CONF-710961.

The ^{12}C(^{6}Li,^{3}He)^{15}N and ^{12}C(^{6}Li,t)^{15}O mirror reactions were studied at 30.8 MeV. The data obtained are accounted for by a three nucleon transfer mechanism. The transfer of ^{3}He and ^{3}T clusters was not observed. (France)

49369 (^{6}Li,^{6}He) SPIN–ISOSPIN-FLIP REACTION. Chuev, V. I.; Davydov, V. V.; Novatskii, B. G.; (and others) (Inst. of Atomic Energy, Moscow). J. Phys. (Paris), Colloq.; No. 6, 167-8(1971).

From Symposium on heavy ion reactions and many particle excitations; Saclay, France (8 Sep 1971). See CONF-710961.

The (^{6}Li,^{6}He) reaction was investigated on ^{7}Li, ^{9}Be, and ^{13}C target nuclei at 31.8 MeV. In some cases, the observed selectivity of the reaction can be accounted for a simple single particle interaction mechanism. (France)

49370 TRANSFER OF EIGHT NUCLEONS ON SOME LIGHT NUCLEI. Conjeaud, M.; Harar, S.; Da Silveira, E.; Volant,

C. (CEN de Saclay, Gif-sur-Yvette, France). J. Phys. (Paris), Colloq.; No. 6, 169-70(1971).

From Symposium on heavy ion reactions and many particle excitations; Saclay, France (8 Sep 1971). See CONF-710961.

The (^{14}N,^{6}Li) reactions were studied with ^{12}C, ^{14}C, ^{16}O, and ^{24}Mg targets, at 45 MeV and at forward angles. The spectra obtained were compared with those observed in (^{7}Li,t) and (^{6}Li,d) reactions. The multiparticle configurations of some excited states in the residual nuclei are discussed. (France)

49371 FINITE RANGE DWBA PROGRAM FOR MULTI-NUCLEON TRANSFER REACTIONS AND A COMPARISON WITH (^{6}Li,t) AND (^{6}Li,d) REACTIONS. Devries, R. M.; Bassani, G. (CEN de Saclay, Gif-sur-Yvette, France). J. Phys. (Paris), Colloq.; No. 6, 175-7(1971).

From Symposium on heavy ion reactions and many particle excitations; Saclay, France (8 Sep 1971). See CONF-710961.

The predictions of an exact finite-range DWBA program are compared with the experimental data for the excitation of a few states in ^{16}O produced in (^{6}Li,t) and (^{6}Li,d) reactions. Calculations using the zero-range and fixed-range approximations suggest that only exact finite range calculations give quantitative spectroscopic information. (France)

49372 TRANSFER REACTIONS BETWEEN ^{18}O IONS AND LIGHT NUCLEI. Eyal, Y.; Dostrovsky, I.; Fraenkel, Z. (Weizmann Inst. of Science, Rehovoth, Israel). J. Phys. (Paris), Colloq.; No. 6, 189-91(1971).

From Symposium on heavy ion reactions and many particle excitations; Saclay, France (8 Sep 1971). See CONF-710961.

The experimental $^{18}O(^{18}O,^{20}O)^{16}O$ and $^{14}C(^{18}O,^{20}O)^{12}C$ 2-neutron transfer reaction cross sections are compared with the corresponding single-neutron transfer reactions. The 2-neutron transfer reactions are found to have a considerably larger cross section at bombarding energies near the Coulomb barrier. The experimental excitation function and angular distribution of the $^{26}Mg(^{18}O,^{16}O)^{28}MG$ 2-neutron transfer reaction are compared to calculations based on the DWBA method and the diffraction model. (France)

49373 INTERMEDIATE STRUCTURE IN THE ^{12}C–^{12}C SCATTERING. Fink, H. J.; Scheid, W.; Greiner, W. (Univ., Frankfurt am Main). J. Phys. (Paris), Colloq.; No. 6, 193-5(1971).

From Symposium on heavy ion reactions and many particle excitations; Saclay, France (8 Sep 1971). See CONF-710961.

It is suggested that in the ^{12}C–^{12}C-scattering quasibound molecular states of the ion–ion-system are formed. The excitation of quasimolecular states leads to a large intermediate structure in the cross sections for energies above the Coulomb barrier. (France)

49374 $^{12}C(^{16}O,\alpha)^{24}Mg$ EXCITATION FUNCTIONS. Greenwood, L. R.; Braid, T. H.; Katori, K.; Stoltzfus, J. C.; Siemssen, R. H. (Argonne National Lab., Ill.). J. Phys. (Paris), Colloq.; No. 6, 199-8(1971).

From Symposium on heavy ion reactions and many particle excitations; Saclay, France (8 Sep 1971). See CONF-710961.

High-resolution excitation functions were measured in 54-keV steps from $E_{c.m.}$ = 19 to 25 MeV for the $^{12}C(^{16}O,\alpha)$ reaction to ten states in ^{24}Mg. The observed strong fluctuation of the excitation function indicates a predominantly compound nucleus process. (France)

49375 CALCULATIONS OF GROUND AND EXCITED STATES OF DEFORMED NUCLEI. Grin, Yu. T.; Kochetov, A. B. (Inst. of Atomic Energy, Moscow). J. Phys. (Paris), Colloq.; No. 6, 203-4(1971).

From Symposium on heavy ion reactions and many particle excitations; Saclay, France (8 Sep 1971). See CONF-710961.

Binding energies, radii, quadrupole moments, deformation parameters and moments of inertia of light nuclei are calculated in the approximation of the minimal K of the K-harmonic method. (France)

49376 MANY-PARTICLE EXCITATIONS IN ^{12}C AND ^{16}O NUCLEI. Grin, Yu. T.; Leinson, L. B. J. Phys. (Paris), Colloq.; No. 6, 205-6(1971).

From Symposium on heavy ion reactions and many particle excitations; Saclay, France (8 Sep 1971). See CONF-710961.

The energies, quadrupole moments of excited configurations in ^{12}C and ^{16}O are calculated. The correlation between the results obtained and the cluster model is discussed. (France)

49377 FORMATION OF ^{6}Li IN MULTINUCLEON TRANSFER REACTIONS. Klages, W. J.; Duhm, H. H.; Homeyer, H.; Schumacher, P. E.; Yoshida, H. (Max-Planck-Institut fuer Kernphysik, Heidelberg). J. Phys. (Paris), Colloq.; No. 6, 209-14(1971).

From Symposium on heavy ion reactions and many particle excitations; Saclay, France (8 Sep 1971). See CONF-710961.

The $^{4}He(^{3}He,p)^{6}Li$, $^{19}F(\alpha,^{6}Li)^{17}O$, $^{19}F(^{3}He,^{6}Li)^{16}O$, and $^{12}C(^{3}He,^{6}Li)^{9}Be$ reactions were analyzed using finite range DWBA calculations to study the α–d and ^{3}He–t structures of the ^{6}Li ground state. (France)

49378 INVESTIGATION OF THE REACTION $^{12}C(^{14}N,d)^{24}Mg$. Klapdor, H. V.; Marquardt, N.; Reiss, H. (Max-Planck-Institut fuer Kernphysik, Heidelberg). J. Phys. (Paris), Colloq.; No. 6, 217-18(1971).

From Symposium on heavy ion reactions and many particle excitations; Saclay, France (8 Sep 1971). See CONF-710961.

The $^{12}C(^{14}N,d)^{24}Mg$ reaction was studied using a 52-MeV $^{14}N^{5+}$ beam. Angular distributions of ^{24}Mg states up to 25 MeV were measured with a multigap spectrograph. The preliminary results show that the high spin states preferentially excited in the (^{16}O,α) and (^{12}C,α) reactions are also heavily populated in the (^{14}N,d) reaction. (France)

49379 EIGHT-NUCLEON TRANSFER AND MULTIPARTICLE EXCITATION BY THE (^{14}N,^{6}Li) REACTION. Marquardt, N.; von Oertzen, W.; Walter, R. L. (Max-Planck-Institut fuer Kernphysik, Heidelberg). J. Phys. (Paris), Colloq.; No. 6, 229-31(1971).

From Symposium on heavy ion reactions and many particle excitations; Saclay, France (8 Sep 1971). See CONF-710961.

The excitation functions and angular distributions of the $^{12}C(^{14}N,^{6}Li)$ reaction were measured at 52 MeV. This reaction involves a direct mechanism. High spin states in ^{20}Ne are preferentially excited. In the energy range studied, only the excitation function of the first 4^+ state revealed a resonance structure. (France)

49380 STUDY OF THE $^{12}C(^{12}C,\alpha)^{20}Ne$ REACTIONS AT HIGH ENERGIES. Panagiotou, A. D.; Gove, H. E. (Univ. of Rochester, N. Y.). J. Phys. (Paris), Colloq.; No. 6, 237-9(1971).

From Symposium on heavy ion reactions and many particle excitations; Saclay, France (8 Sep 1971). See CONF-710961.

The reaction $^{12}C(^{12}C,\alpha)^{20}Ne$ was studied between 45 and 52 MeV. Excitation functions were obtained to the ground, 2^+(1.63 MeV) and 4^+(4.25 MeV) levels of ^{20}Ne. Angular distributions to the low-lying levels of ^{20}Ne were obtained at $E_{^{12}C}$ = 50 MeV and compared with $[P_1(\text{cos theta})]^2$. The cross section for the reaction depends very strongly on the incident energy and the spin of the ^{20}Ne levels. (France)

49381 STUDY OF THE REACTION $^{16}O + ^{16}O \rightarrow$ MASS 24 + ^{4}He + ^{4}He. A TEST OF THE QUASIMOLECULAR MODEL. Purser, K. H.; Gaardé, C. C.; Gove, H. E.; Kubo, H.; Liebert, R. B. (Univ. of Rochester, N. Y.). J. Phys. (Paris), Colloq.; No. 6, 253-4(1971).

From Symposium on heavy ion reactions and many particle excitations; Saclay, France (8 Sep 1971). See CONF-710961.

Coincident counts of the two alpha particles emitted in the reaction $^{16}O + ^{16}O$ were measured in two E–ΔE detectors located at angles + theta and – theta to the 60-MeV incident beam. The coincidences were measured as a function of theta. No evidence for an increase in yield was found when the angles were ±90 deg in the center of mass. (France)

49382 STABILITY OF EXCITED STATES AND BAND CUT-OFF IN LIGHT 4 N-NUCLEI. Satpathy, L. (Kernforschungsanlage, Juelich, Ger.); Friedrich, H.; Weiguny, A. J. Phys. (Paris), Colloq.; No. 6, 269-70(1971).

From Symposium on heavy ion reactions and many particle excitations; Saclay, France (8 Sep 1971). See CONF-710961.

Using the α-cluster model, the relative instability of excited states with respect to α-decay and the resulting band cut-off of ^{12}C and ^{20}Ne are studied by calculating the angular momentum projected energies as functions of the separation between an α-particle and the residual nucleus. (France)

49383 STRUCTURE OF ^{15}N INVESTIGATED BY HEAVY ION INDUCED TRANSFER REACTIONS. Schlotthauer Voos, U. C. (Univ., Marburg, Ger. Max-Planck-Institut fuer Kernphysik, Heidelberg). J. Phys. (Paris), Colloq.; No. 6, 271-3(1971).

From Symposium on heavy ion reactions and many particle excitations; Saclay, France (8 Sep 1971). See CONF-710961.

The structure of ^{15}N was investigated by heavy ion induced proton-, triton-, and alpha-transfer reactions. (France)

49384 ONE, TWO, AND THREE-NUCLEON TRANSFER REACTIONS INDUCED BY ^{12}C IONS ON ^{12}C, ^{16}O, AND ^{40}Ca. Scott, D. K.; Cardinal, C. U.; Fisher, P. S.; Hudson, P.; Anyas-Weiss, N. (Oxford Univ.). J. Phys. (Paris), Colloq.; No. 6, 275-7(1971).

From Symposium on heavy ion reactions and many particle excitations; Saclay, France (8 Sep 1971). See CONF-710961.

One, two, and three nucleon transfer reactions were studied at 114 MeV on targets of ^{12}C, ^{16}O, and ^{40}Ca. A prominent feature of all the reactions is the selective population of levels in the residual nuclei, in an excitation range covering 50 MeV. The excitations can be explained by a semiclassical argument. (France)

49385 ^{16}O(^{16}O,^{12}C)^{20}Ne REACTIONS. Singh, P. P. (Indiana Univ., Bloomington); Sink, D. A.; Schwandt, P.; Malmin, R. E.; Siemssen, R. H. J. Phys. (Paris), Colloq.; No. 6, 279-82 (1971).

From Symposium on heavy ion reactions and many particle excitations; Saclay, France (8 Sep 1971). See CONF-710961.

Differential cross sections from 17.5 to 30 MeV c.m. energy at about 90, 75, and 60° (cm) were measured for ^{16}O(^{16}O,^{12}C)^{20}Ne reactions leading to the ground state, the 1.63 MeV 2^+ state, and the 4.25-MeV 4^+ state of ^{20}Ne and/or the 4.43-MeV 2^+ state of ^{12}C. The yield curves have both gross and narrow structures of approximately 1.5 and 0.5 MeV in width, respectively. Strong correlations are seen among the yield curves for different angles and also among those for different final states. (France)

49386 REACTIONS ^{14}N(^{6}Li,^{7}Li)^{13}N AND ^{14}N(^{6}Li,^{7}Be)^{13}C AT 32 MeV. Zeidman, B.; Strohbusch, U.; Richter, A.; Groeneveld, K. O. (Argonne National Lab., Ill.). J. Phys. (Paris), Colloq.; No. 6, 295-7(1971).

From Symposium on heavy ion reactions and many particle excitations; Saclay, France (8 Sep 1971). See CONF-710961.

Angular distributions for the one-nucleon transfer reactions ^{14}N(^{6}Li,^{7}Li)^{13}N and ^{14}N(^{6}Li,^{7}Be)^{13}C were investigated at E(^{6}Li) = 32 MeV and were compared with finite-range distorted-wave calculations and theoretical spectroscopic factors. (France)

49387 (d,n) THICK-TARGET YIELDS AND TOTAL CROSS SECTIONS BETWEEN 1 AND 40 MeV. Lucas, Larry L.; Root, John W. (Univ. of California, Davis). J. Appl. Phys.; 43: No. 9, 3886-8(Sep 1972).

New results are reported for (d,n) neutron yields, total cross sections, and zero-degree energy spectra for Li, Be, C, and Al targets and for bombarding energies ranging from 15 to 40 MeV. Semiempirical equations were derived from the available (d,n) thick-target total cross section and total yield data. (auth)

49388 MULTISTEP PROCESSES IN THE (d,^{6}Li) REACTION. Comfort, J. R. (Princeton Univ., N. J.); Braithwaite, W. J.; Duray, J. R.; (and others). Phys. Lett.; 40B: No. 4, 456-8(24 Jul 1972).

At 28 MeV, the (d,^{6}Li) reaction on A = 4n targets in the 1p and 2s–1d shells systematically populates unnatural-parity states with large relative cross sections. This result suggests the presence of multistep reaction processes, making questionable the extraction of nuclear-structure information with DWBA. (auth)

Nuclear Properties and Reactions, $20 \leq A \leq 38$

Refer also to abstracts 49344, 49345, 49348, 49354, 49370, 49372, 49375, 49378, 49379, 49382, 49384, 49387, 49388, 49405, and 49450.

49389 (COO–1573-100) NUCLEAR PHYSICS LABORATORY FINAL REPORT FOR THE PERIOD NOVEMBER 1, 1970–JANUARY 31, 1972. (Case-Western Reserve Univ., Cleveland, Ohio. Dept. of Physics). 1972. Contract AT(11-1)-1573. 42p. Dep. NTIS.

NEON-20—helium-3 reactions (He-3,n) at 3.0 to 4.3 MeV, differential cross sections and excitation functions for, (E)
NEUTRONS—detection and discrimination from gamma radiation, description of system for
RAD. DET. SCINTILLATION (SOLID)—efficiency of NE-213 (R.W.R.)

49390 (FRNC-TH–193) STUDY OF REACTIONS INVOLVING THE TRANSFER OF A NEUTRON USING A POLARIZED PROTON BEAM. Mayer, Benjamin (Paris Univ., Orsay (France)). 1971. 127p. (In French). Dep. NTIS (U. S. Sales Only).

Thesis.

A beam of polarized protons was used to study (p,d) reactions with nuclei having mean masses between 32 and 119. The asymmetries were measured for all values of the orbital angular momentum between 1 = 0 and 1 = 5. Nuclei around the closed neutron or proton shells (excluding ^{32}S and ^{34}S) were chosen in order to avoid nuclear deformation effects. The choice of target was otherwise limited by the fact that the residual nucleus states must be sufficiently far apart to be resolved. The experimental equipment is described and the angular distribution of the cross sections and the asymmetries for the (p,d) reactions with ^{32}S, ^{34}S, ^{48}Ca, ^{49}Ti, ^{53}Cr, ^{57}Fe, ^{58}Ni, ^{61}Ni, ^{90}Zr, ^{91}Zr, ^{92}Mo, ^{118}Sn, and ^{119}Sn are given for an energy in the region of 20 MeV. The results obtained established the existence of a strong j dependence of the asymmetry and are in qualitative agreement with the DWBA. Various families of deuteron optical potentials which take into reasonable account the elastic scattering were used in the calculations. The asymmetry is apparently more sensitive to the choice of this potential than the cross section. It is demonstrated that the distribution of the D state of the internal wave function of the deuteron has a considerable effect on the asymmetry. (France)

49391 (LBL–781) STUDY OF NUCLEAR STRUCTURE FROM THE ANALYSIS OF γ RAYS FOLLOWING μ^- CAPTURE IN Al, Si, Ca, AND Co. Temple, L. Edward Jr. (California Univ., Berkeley. Lawrence Berkeley Lab.). 24 May 1972. Contract W-7405-eng-48. 143p. Dep. NTIS.

Thesis.

An analysis of γ rays emitted following μ^- capture in ^{27}Al, ^{28}Si, ^{40}Ca, and ^{59}Co has been carried out with the intention of studying the structure of the nuclear states excited in the muon capture reaction. The results of this experiment are correlated and compared with the results of single nucleon pick-up reactions, photoexcitation and electroexcitation studies, and thermal neutron capture experiments as well as with theoretical nuclear structure calculations. The close correlation of the states populated in ^{39}K following muon capture in ^{40}Ca with those populated in the single nucleon pickup reaction ^{40}Ca(t,α)^{39}K indicates that single hole states are populated preferentially in the residual ^{39}K nucleus when a single neutron is emitted following the muon capture. An identification of the states formed in ^{28}Al following muon capture in ^{28}Si with levels thought to be configuration mixed particle-hole states is made. The strong excitation of the third excited state in ^{27}Al following muon capture in ^{28}Si when contrasted with the absence of evidence for a proton group corresponding to the excitation of this level in the ^{28}Si(γ,p)^{27}Al reaction demonstrates that additional states are excited in muon capture which are not excited in photoexcitation. The populations of states in ^{26}Mg in the ^{27}Al(μ^-,νn)^{26}Mg and ^{27}Al(γ,pγ')^{26}Mg reactions correlate closely and this may be evidence that the photoexcitation reaction is proceeding via the $\Delta T = 1$ branch. The results are discussed in the context of other muon capture experiments which measure neutron multiplicities, charged particle emission, and no particle emission. A comparison with other gamma spectra measurements is made for Si, Ca, and Co. (auth)

49392 (ORO–2098-90) STRUCTURE OF THE LIGHT NUCLEI. Final Report, December 1, 1970–November 30, 1971. Maryland Univ., College Park. Dept. of Physics and Astronomy). 1972. Contract AT(40-1)-2098. 21p. Dep. NTIS.

The spectroscopy of excited states of the nuclei ^{10}B, ^{15}N, ^{18}F and ^{27}Si has been investigated. Particle-particle correlation measurements have been carried out to establish spin-parity values of 3^-, 4^- and 3^+ for the 6.13, 6.57 and 7.00 MeV levels of ^{10}B respectively. Also this technique has been used to establish unambiguously that the isospin mixed 5.61 and 5.67 MeV levels of ^{18}F are both 1^- levels. Negative parity states at 9.15 and 9.22 MeV excitation in ^{15}N have been identified and interpreted in terms of two-particle, three-hole configurations. Evidence has also been presented for small admixtures of these configurations in the ground and 6.32 MeV states of ^{15}N. Particle-gamma correlation measurements have been used to determine γ-ray branching ratios, spins and multipole-mixing ratios for the first six excited states of ^{27}Si. Finally, the elastic scattering of 65 MeV protons and deuterons from isotopes of oxygen has been measured and used in an investigation of the ^{16}O(d,p)^{17}O reaction to extract spectroscopic factors for bound and unbound states of ^{17}O. Some of the data presented has previously appeared in journal publications. (auth)

49393 (^{3}He,t) AND (^{3}He,^{3}He') REACTIONS IN THE 2s–1d SHELL. Holden, James Edward. Philadelphia; Univ. of Pennsylvania (1971). 137p. University Micrfilms Order No. 72-17,368.

Thesis.

The (^{3}He,t) charge-exchange reactions on ^{23}Na, ^{27}Al, and ^{29}Si and the (^{3}He,^{3}He') inelastic scattering reaction on ^{27}Al were studied using an 18 MeV beam of ^{3}He^{++} ions from the University of Pennsylvania Tandem Accelerator. Emerging particles were detected in a system of solid state detector telescopes, and the data recorded in a magnetic tape buffer; triton and ^{3}He energy spectra were then generated off-line using digital particle identification in a PDP-9 computer. Triton angular distributions were measured from 10° to 75° laboratory angle; the angular range for the inelastic scattering experiment was 20° to 75° laboratory angle. The experimental results were analyzed in the distorted-wave Born approximation using both the macroscopic and microscopic models of the effective interaction. The purpose of the study was threefold. First, the use of the (^{3}He,t) reaction as a spectroscopic tool was considered in the context of the experimental results; evidence of sensitivity to final state configurations indicated that while the reaction may not provide unambiguous spin assignments, it should be useful for studying the detailed structure of states of known spin. Second, (^{3}He,^{3}He′) and (^{3}He,t) transitions to known collective levels were used to study the macroscopic or collective reaction model of these reactions. Finally, a formalism was developed for the calculation of charge-exchange cross-sections to strong coupling levels by means of the microscopic reaction model, and was applied to members of known rotational bands in ^{23}M and ^{29}P. (Diss. Abstr. Int., B)

49394 DOORWAY STATES AND BACKGROUND CROSS SECTIONS IN ^{29}Si(γ,n). Jackson, H. E.; Toohey, R. E. (Argonne National Lab., Ill.). Phys. Rev. Lett.; 29: No. 6, 379-82(7 Aug 1972).

A study of the reaction ^{29}Si(γ,n) near threshold suggests that a doorway state with $J^\pi = 3/2^-$ common to the channels ^{28}Si + n and ^{29}Si + γ lies near 750 keV. Lane's prediction of a significant nonresonant background cross section associated with strong partial-width correlations was observed experimentally. (auth)

49395 SHELL MODEL, QUARTETS, AND ROTONS IN THE s–d SHELL. Arima, A. (State Univ. of New York, Stony Brook). J. Phys. (Paris), Colloq.; No. 6, 33-7(1971).

From Symposium on heavy ion reactions and many particle excitations; Saclay, France (8 Sep 1971). See CONF-710961.

The definition of quartet is given in connection with alpha clusters. The structures of ^{20}Ne, ^{44}Ti, and ^{58}Ni are discussed from the quartet structure point of view. (France)

49396 NEW ISOTOPES: $^{29\ 30}$Mg, $^{31\ 32\ 33}$Al, $^{33\ 34\ 35\ 36}$Si, $^{35\ 36\ 37\ 38}$P, $^{39\ 40}$S, AND $^{41\ 42}$Cl, PRODUCED IN BOMBARDMENT OF ^{232}Th TARGET WITH 290 MeV ^{40}Ar IONS. Artukh, A. G.; Avdeichikov, V. V.; Gridnev, G. F.; (and others) (Joint Inst. for Nuclear Research, Dubna, USSR). J. Phys. (Paris), Colloq.; No. 6, 129-31(1971).

From Symposium on heavy ion reactions and many particle excitations; Saclay, France (8 Sep 1971). See CONF-710961.

Seventeen new nuclides were detected and identified as the products of the ^{232}Th + ^{40}Ar (E_{lab} = 290 MeV) reaction. The charged particle identification system combining the magnetic analysis and the ΔE-E technique was used. (France)

49397 ELASTIC SCATTERING OF ^{6}Li IONS ON MEDIUM AND HEAVY NUCLEI. Chuev, V. I.; Davydov, V. V.; Novatskii, B. G.; (and others). (Inst. of Atomic Energy, Moscow). J. Phys. (Paris), Colloq.; No. 6, 157-9(1971).

From Symposium on heavy ion reactions and many particle excitations; Saclay, France (8 Sep 1971). See CONF-710961.

The elastic scattering of ^{6}Li ions on ^{28}Si, ^{40}Ca, ^{58}Ni, ^{120}Sn, ^{197}Au, ^{208}Pb was studied within the angle range from 10 to 170° at 30 MeV. The results of the optical model analysis are presented. (France)

49398 QUARTET EXCITATION IN ^{20}Ne MAY BE SEEN THROUGH THE DECAY IN ^{8}Be + ^{12}C. Gorodetzky, P.; Rudolf, G.; Scheibling, F.; Chevallier, P. (CNRS, Strasbourg). J. Phys. (Paris), Colloq.; No. 6, 197-8(1971).

From Symposium on heavy ion reactions and many particle excitations; Saclay, France (8 Sep 1971). See CONF-710961.

Preliminary results obtained in the study of the $^{19}F + p \rightarrow {}^8Be + {}^{12}C$ and $^{16}O + \alpha \rightarrow {}^8Be + {}^{12}C$ reactions in the region of excitation of ^{20}Ne(15.3 to 18.7 MeV) show that most of the levels observed are 8 particle–4 hole states and the two biggest resonances could be the head band of the 12 particle–8 hole process. (France)

49399 ^{12}C DECAY OF HIGHLY EXCITED STATES IN ^{24}Mg. Levine, M. J.; Schwalm, D.; Littman, M. G. (Brookhaven National Lab., Upton, N. Y.). J. Phys. (Paris), Colloq.; No. 6, 219-20(1971).

From Symposium on heavy ion reactions and many particle excitations; Saclay, France (8 Sep 1971). See CONF-710961.

The decay of ^{24}Mg into two ^{12}C-particles was studied using the reaction ^{12}C(^{16}O,α)^{24}Mg to populate highly excited states in ^{24}Mg. (France)

49400 STATISTICAL-MODEL CALCULATION OF THE SELECTIVE EXCITATION OF HIGH-SPIN STATES IN ^{24}Mg. Malmin, R. E.; Katori, K.; Greenwood, L. R.; Braid, T. H.; Siemssen, R. H. (Argonne National Lab., Ill.). J. Phys. (Paris), Colloq.; No. 6, 223-4(1971).

From Symposium on avy ion reactions and many particle excitations; Saclay, France (8 Sep 1971). See CONF-710961.

The selective population of high-spin states in ^{24}Mg by ^{12}C(^{16}O,α) ^{24}Mg reaction, as well as the lack of such selectivity in the ^{14}N(^{14}N,α)^{24}Mg reaction, can be explained in terms of a Hauser–Feshbach statistical model calculation. (France)

49401 HIGH-SPIN HIGHLY-EXCITED STATES IN ^{20}Ne AND THEIR POSSIBLE CLASSIFICATION. Panagiotou, A. D.; Gove, H. E.; Harar, S. (Univ. of Rochester, N. Y.). J. Phys. (Paris), Colloq.; No. 6, 241-3(1971).

From Symposium on heavy ion reactions and many particle excitations; Saclay, France (8 Sep 1971). See CONF-710961.

The reaction $^{12}C + {}^{12}C \rightarrow \alpha_1 + {}^{20}Ne^* \rightarrow \alpha_2 + {}^{16}O$ was employed in the measurements of the spin of highly excited states in ^{20}Ne. Angular correlations were obtained using two position sensitive detectors. Two of the new levels, namely the 5-(15.9 MeV) and the 7-(18.10 MeV), may belong to the K = 0$^-$ band of the (86) SU$_3$ symmetry, arising from three-particle core excitation. Results obtained from the ^{16}O(^{6}Li,d)^{20}Ne and ^{16}O(^{7}Li,t)^{20}Ne experiments are presented and discussed. (France)

49402 SHELL-MODEL CALCULATIONS FOR ^{28}Si. Soyeur, M.; Zuker, A. P. (CEN de Saclay, Gif-sur-Yvette, France). J. Phys. (Paris), Colloq.; No. 6, 283-5(1971).

From Symposium on heavy ion reactions and many particle excitations; Saclay, France (8 Sep 1971). See CONF-710961.

Results of extensive shell-model calculations with realistic interactions in ^{28}Si are presented. A good description of the spectrum and electromagnetic properties can be obtained within the conventional (s–d) shell space. Previous calculations using different truncation schemes are discussed. (France)

49403 EXCITED STATES OF ^{31}P AND ^{32}S STUDIED IN THE (p,p′) REACTION AT 185 MeV. Kaellne, J.; Sundberg, O. (Uppsala Univ.). Phys. Scr.; 4: No. 6, 243-55(1971).

The inelastic scattering of protons from targets of natural phosphorus and sulphur has been studied at 185 MeV with a total energy resolution of 370 keV. New spin–parity assignments have been made for some levels in ^{31}P and ^{32}S on the basis of an analysis in the plane-wave impulse approximation and on considerations based on the applicability of the excited-core model. The concepts of this model also explained a systematic appearance of strongly populated levels in the two nuclei. Relative transition strengths have been extracted for the strongest transitions observed. The results are qualitatively discussed within the frameworks of the collective rotor and vibrator models and the shell model. The importance of particle–hole excitations in inelastic proton scattering from ^{31}P and ^{32}S is displayed by a comparison with results of appropriate stripping and pick-up experiments. (auth) (Sweden)

Nuclear Properties and Reactions, 39 ≤ A ≤ 58

Refer also to abstracts 49344, 49348, 49354, 49375, 49390, 49391, 49395–49397, 49417, 49418, and 49450.

49404 (ORNL-TM-3850) NEUTRON-INDUCED GAMMA-RAY PRODUCTION IN IRON FOR THE ENERGY RANGE 0.8 ≤ E_n ≤ 20 MeV. Dickens, J. K.; Morgan, G. L.; Perey, F. G. (Oak Ridge National Lab., Tenn.). Aug 1972. Contract W-7405-eng-26. 60p. Dep. NTIS.

Cross sections for production of gamma rays due to neutron interactions with iron were measured as a function of both neutron and gamma-ray energy. Two experimental configurations were used to obtain the data, and these were (a) a NaI-spectrometer system using the Oak Ridge Linear Accelerator as the neutron source, and (b) a Ge(Li)-spectrometer system using a pulsed Van de Graaff and the D(d,n) reaction as the neutron source. The NaI-spectrometer system is described completely in this report. It was used to acquire data for $0.8 \le E_n \le 20$ MeV and θ_γ = 125 deg, which were unfolded to obtain $d^2\sigma/d\omega dE$ values for gamma-ray energies between 0.7 and 10 MeV. The Ge(Li) system was used to obtain high-resolution information on the production of discrete-line $d\sigma/d\omega$ values for $4.85 \le E_n \le 9.0$ MeV and θ_γ = 55, 75 and 90 deg. Our data are compared with previously reported experimental data and with the current ENDF/B evaluation. Although there is generally reasonable (20%) agreement, important differences among these data are discussed. (auth)

49405 (UCRL-73731) (p,n) CHARGE EXCHANGE REACTION. Anderson, J. D. (California Univ., Livermore. Lawrence Livermore Lab.). 9 May 1972. 30p. (CONF-720444-1). Dep. NTIS.

From Meeting of the American Physical Society; Washington, D. C. (24 Apr 1972).

Some results on (p,n) reactions with ^{26}Mg, ^{51}V, ^{55}Mn, ^{56}Fe, Ni, ^{63}Cu, ^{93}Nb, and Zr at energies of 12 to 26 MeV are discussed. (J.W.R.)

49406 ^{16}O-INDUCED TRANSFER REACTIONS IN THE f–p SHELL. Morrison, G. C. (Argonne National Lab., Ill.). J. Phys. (Paris), Colloq.; No. 6, 69-81(1971).

From Symposium on heavy ion reactions and many particle excitations; Saclay, France (8 Sep 1971). See CONF-710961.

A systematic investigation of ^{16}O-induced transfer reactions on a wide range of fp-shell target nuclei from ^{40}Ca to ^{70}Zn was performed, mainly at a bombarding energy of 48 MeV. The principal reactions observed are $(^{16}O,^{15}N)$, $(^{16}O,^{14}C)$ and $(^{16}O,^{12}C)$, their direct nature being found in the systematic variation of the angular distributions with Q, Z, and E. The results of finite-range DWBA calculations for the $(^{16}O,^{15}N)$ reaction are presented, and the very important role of angular momentum in heavy-ion reaction dynamics is made explicit. (France)

49407 $^{54}Fe(^{16}O,^{12}C\gamma)^{58}Ni$ REACTION AT 48 MeV. Beuzit, P.; Ballini, R.; Delaunay, J.; (and others) (CEN de Saclay, Gif-sur-Yvette, France). J. Phys. (Paris), Colloq.; No. 6, 139-40(1971).

From Symposium on heavy ion reactions and many particle excitations; Saclay, France (8 Sep 1971). See CONF-710961.

The gamma spectra in coincidence with outgoing ^{12}C in the $^{54}Fe(^{16}O,^{12}C\gamma)^{58}Ni$ reaction were measured. The 3.53 (0^+) and 4.47 MeV (3_1^-) levels were identified. The strong peak at 6.0 MeV corresponds to the excitation of several states decaying directly to the ground. (France)

49408 DIRECT TRANSFER REACTIONS INDUCED BY ^{16}O AT INCIDENT ENERGIES ABOVE THE COULOMB BARRIER. Cunsolo, A.; Faraggi, H.; Lemaire, M. C.; (and others) (CEN de Saclay, Gif-sur-Yvette, France). J. Phys. (Paris), Colloq.; No. 6, 171-3(1971).

From Symposium on heavy ion reactions and many particle excitations; Saclay, France (8 Sep 1971). See CONF-710961.

Transfer reactions induced by ^{16}O ions on various 1f-2p shell target nuclei, exhibit the general features of a surface direct reaction which can be described as a quasi-elastic process in the framework of the Frahn and Venter diffraction model. The great selectivity of these direct transfer reactions can be applied to spectroscopic studies. (France)

49409 GAMMA TRANSITIONS IN ^{44}Ti AND ^{48}Cr FROM HEAVY ION INDUCED REACTIONS. Huber, R. B. (Technische Hochschule, Munich); Kutschera, W.; Signorini, C.; Blasi, P. J. Phys. (Paris), Colloq.; No. 6, 207-8(1971).

From Symposium on heavy ion reactions and many particle excitations; Saclay, France (8 Sep 1971). See CONF-710961.

Excited states of ^{44}Ti were studied using the $^{32}S(^{14}N,pn)^{44}Ti$ reaction. The lifetimes of the 1083 keV (2^+) and 2454 keV (4^+) levels were determined. The first excited state of ^{48}Cr was identified at 752 ± 1 keV using the $^{40}Ca(^{10}B,pn)^{48}Cr$ reaction and proton–neutron–γ triple coincidence measurements. (France)

49410 NUCLEAR TRANSFER REACTIONS INDUCED BY ^{16}O IONS ON NUCLEI IN THE f–p SHELL. Manko, V. J.; Becchetti, F. D.; Christensen, P. R.; Nickles, R. J. (Niels Bohr Institutet, Copenhagen). J. Phys. (Paris), Colloq.; No. 6, 225-7(1971).

From Symposium on heavy ion reactions and many particle excitations; Saclay, France (8 Sep 1971). See CONF-710961.

Multi-nucleon transfer reactions induced by a 60-MeV ^{16}O beam in the following even-even target nuclei: ^{40}Ca, ^{48}Ca, ^{50}Ti, ^{52}Cr, ^{54}Fe, ^{58}Ni, ^{60}Ni, ^{62}Ni, ^{64}Ni, and ^{64}Zn, were studied. A strong kinematic dependence of the cross sections of these reactions is deduced. (France)

49411 Q-VALUE DEPENDENCE IN THE FOUR-NUCLEON TRANSFER REACTION $^{54}Fe(^{16}O,^{12}C)^{58}Ni$. von Oertzen, W. (Max-Planck-Institut fuer Kernphysik, Heidelberg). J. Phys. (Paris), Colloq.; No. 6, 233-5(1971).

From Symposium on heavy ion reactions and many particle excitations; Saclay, France (8 Sep 1971). See CONF-710961.

DWBA calculations were used to study the dependence of the differential cross sections of $(^{16}O,^{12}C)$ reactions on the Q-value. It is found that the optimum Q-value for the $(^{16}O,^{12}C)$ reaction with ^{54}Fe at 52 MeV is approximately −6 MeV and that the cross sections decrease by more than an order of magnitude if the real Q-value deviates from the optimum value by ±5 MeV. (France)

49412 TRANSFER REACTIONS ON ^{54}Fe WITH A 80 MeV ^{16}O BEAM. Pougheon, F.; Colombani, P.; Doubre, H.; (and others) (Paris Univ., Orsay, France). J. Phys. (Paris), Colloq.; No. 6, 249-51(1971).

From Symposium on heavy ion reactions and many particle excitations; Saclay, France (8 Sep 1971). See CONF-710961.

The transfer of one or many nucleons induced by an 80-MeV ^{16}O beam onto a ^{54}Fe target was studied. The reactions are very selective. Excited levels of high energy are obtained and their main characteristics are deduced. (France)

49413 HEAVY ION REACTION CHANNELS DETERMINED FROM INDUCED RADIOACTIVITY MEASUREMENTS. Robinson, R. L.; Kim, H. J.; Ford, J. L. C. (Oak Ridge National Lab., Tenn.). J. Phys. (Paris), Colloq.; No. 6, 265-8(1971).

From Symposium on heavy ion reactions and many particle excitations; Saclay, France (8 Sep 1971). See CONF-710961.

Gamma-ray measurements following heavy ion bombardment were used to determine the absolute cross sections for different reaction channels. The radioactive products were identified by half-life, gamma-ray energies, and intensities. Reaction products formed by the bombardment of ^{58}Ni, ^{60}Ni targets with 38- to 46-MeV oxygen ion were studied. (France)

49414 ^{40}Ca STATES EXCITED BY FOUR NUCLEON TRANSFER REACTIONS. Tellez, A.; Ballini, R.; Fodor, I.; Fouan, J. P. (CEN de Saclay, Gif-sur-Yvette, France). J. Phys. (Paris), Colloq.; No. 6, 287-8(1971).

From Symposium on heavy ion reactions and many particle excitations; Saclay, France (8 Sep 1971). See CONF-710961.

The transfer of four nucleons onto ^{36}Ar, leading to excited states of ^{40}Ca was observed using the $(^{7}Li,t)$ and $(^{16}O,^{12}C\gamma)$ reactions. (France)

49415 MAGNETIC MOMENT OF THE LOWEST 6^+ STATE IN ^{42}Ca. Nomura, Toru (Tokyo Univ.); Yamazaki, Toshimitsu; Nagamiya, Shoji. J. Phys. Soc. Jap.; 33: No. 2, 286-97(Aug 1972).

The g factor of the 3190-keV 6^+ state in ^{42}Ca was measured by the time-differential perturbed-angular-distribution method in the $^{40}Ca(\alpha,2p)^{42}Ca$ reaction. The result is $g = -(0.50^{+0.02}_{-0.03})$. For the assumption of a $0.99f_{7/2}^2 + 0.13f\ f_{7/2}$ configuration for the $6_{7/2}^+$ state, the magnetic moment for the $0f_{7/2}$ neutron is deduced to be $-1.99\mu_N$, very different from the known magnetic moment of the ^{41}Ca ground state. The strong violation of the additivity relation is interpreted by a larger mixing of the core-excited deformed states into the ^{41}Ca ground state. The above magnetic moment for the $0f_{7/2}$ neutron supports recent proposal that the orbital g factor is enhanced in nuclei by around $0.1\tau_z$ if the quenching due to the second-order core polarization is taken into account. (7 figures, 6 tables) (auth)

Nuclear Properties and Reactions, $59 \leq A \leq 89$

Refer also to abstracts 49344, 49390, 49391, 49405, 49410, 49413, and 49450.

49416 (ORO–4282-2) NUCLEAR CHEMISTRY. Annual Progress Report. Kuroda, P. K. (Arkansas Univ., Fayetteville. Dept. of Chemistry). 31 Jul 1972. Contract AT(40-1)-4282. 87p. Dep. NTIS.

Results obtained between July 1971 and July 1972 are summarized. The work discussed has already appeared, or soon will appear, in journals; however, nine reprints and four preprints are included as appendixes. Brief reports on the Cockcroft–Walton accelerator and instrumentation are given. (R.W.R.)

49417 (RCN–170) INTERNAL CONVERSION MEASUREMENTS. Pleiter, F. (Reactor Centrum Nederland, Petten). Jul 1972. 112p. Dep. NTIS (U. S. Sales Only).

Accurate internal conversion ratios are presented for the isomeric transitions in ^{58m}Co, ^{60m}Co, ^{83m}Kr, and ^{134m}Cs. These measurements were undertaken to determine possible multipole mixtures. The electron spectrum associated with the decay of ^{116m}In was measured in order to find evidence for an electric monopole transition. The combined results of conversion electron and Mössbauer measurements on the well known 14.4 keV transition in ^{57}Fe performed to determine the nuclear radius change during this transition are presented. (auth)

49418 FOUR-NUCLEON TRANSFERS AND LOW-LYING QUARTET STATES IN THE 1f–2p SHELL. Faraggi, H. (CEN de Saclay, Gif-sur-Yvette, France). J. Phys. (Paris), Colloq.; No. 6, 25-31(1971).

From Symposium on heavy ion reactions and many particle excitations; Saclay, France (8 Sep 1971). See CONF-710961.

In a search for the presence of low-lying quartet structures in the 1f-2p shell, a possible experimental approach is offered by performing direct α-transfer reactions with heavy ion beams such as ^{16}O or ^{20}Ne, on doubly even targets around the ^{40}Ca, ^{48}Ca, and ^{56}Ni cores. The overall features of these reactions, for incident energies in the vicinity of the Coulomb barrier, are in qualitative agreement with the predictions of a quartet model. (France)

49419 ^{65}Ga DECAY AND THE LEVEL SCHEME OF ^{65}Zn. Numao, Toshio; Takigishi, Shinichi; Chica, Ren (Tokyo Inst. of Tech.). J. Phys. Soc. Jap.; 33: No. 2, 281-5(Aug 1972).

The decay of 15-min ^{65}Ga to the levels of ^{65}Zn was studied with a 35-cm^3 Ge(Li) detector. Gamma rays of about forty energies were observed. A decay scheme is proposed. (2 figures, 2 tables) (auth)

49420 ABOUT THE NON-EXISTENCE OF 4.2m /sup 78m/Rb. de Boer, F. W. N.; Koldewijn, P.; Konijn, J.; Lingeman, E. W. A. (Instituut voor Kernphysisch Onderzoek, Amsterdam). Radiochim. Acta; 17: No. 2, 116-17(Jul 1972).

A ^{79}Br target, enriched to 99%, was bombarded by ^{3}He particles with energies varying from 40 to 70 MeV. A chemical separation was done, and gamma spectra were measured by using a high-resolution Ge(Li) detector. It was concluded that previous evidence for the existence of ^{78m}Rb was incorrect (the transition assigned to ^{78m}Rb being in reality a complex peak belonging to transitions in ^{77}Br and ^{78}Rb), and that no 4.2-min ^{78m}Rb isomer exists. (1 figure) (R.W.R.)

Nuclear Properties and Reactions, $90 \leq A \leq 149$

Refer also to abstracts 48355, 49344, 49345, 49354, 49390, 49397, 49405, 49417, 49451, and 49488.

49421 (ANCR-1068) C-SURE: CROSS SECTIONS FOR UNRESOLVED RESONANCES FROM ENDF/B. Singer, G. L.; Grimesey, R. A. (Aerojet Nuclear Co., Idaho Falls, Idaho). May 1972. Contract AT(10-1)-1375. 63p. Dep. NTIS.

The C-SURE code calculates unresolved capture, fission, and compound elastic scattering cross sections from ENDF/B data at energies specified by input. These calculations include Doppler broadening to provide temperature dependent data, so that self-shielding can automatically be accounted for in the unresolved resonance calculation. The program includes the following features: minimum card input, and ENDF/B update facility, and the option of a separate printout of the s-wave and p-wave unresolved resonance contributions. (auth)

49422 (AWRE-O-66/71) ELASTIC AND INELASTIC SCATTERING OF NEUTRONS IN THE ENERGY RANGE 1.0 TO 5.0 MeV BY NATURAL NIOBIUM. Coles, R. E. (Atomic Weapons Research Establishment, Aldermaston (England)). Nov 1971. 33p. (EANDC-137-AL).

The time-of-flight method has been used to study fast neutron elastic and inelastic scattering by niobium in the energy range 1.0 to 5.0 MeV. Differential cross sections were measured at ten angles from 30° to 135°, at 0.5 MeV intervals between 1.5 and 5.0 MeV incident neutron energy, for elastic scattering, inelastic scattering to levels up to 2590 keV excitation in the target nucleus and inelastic scattering to a continuum above 2590 keV excitation. Excitation functions were derived from 125° yields measured at 0.2 MeV intervals between 1.0 and 3.0 MeV incident neutron energy for inelastic scattering. The continuum spectra for incident neutron energies between 3.5 and 5.0 MeV have been analysed in terms of statistical evaporation theory and parameters describing the secondary energy distributions of the continuum scattered neutrons extracted. No attempt has been made to compare the data in this report with theoretical predictions. However, comparisons are made with other published data where appropriate. (auth)

49423 (DESY-72/27) PHOTON INDUCED NUCLEAR REACTIONS ABOVE 1 GeV. II. SPALLATION REACTIONS. Lindgren, K.; Jonsson, G. G. (Deutsches Elektronen-Synchrotron, Hamburg (West Germany)). Jun 1972. 20p. Dep. NTIS (U. S. Sales Only).

Previously reported studies on spallation reactions in I and Au at intermediate energies have been extended to the GeV region. The yield and cross section distributions in iodine are analyzed with the five-parameter formulas given by Rudstam and the values of the parameters obtained are discussed. At intermediate energies, some Monte Carlo calculations based on the cascade-evaporation model have been carried out and agreement between calculations and experiment is obtained. The experimental (γ,xn) cross sections in gold are compared to estimates from the Rudstam CDMD formula. (auth)

49424 (JINR-E7-6480) EXPERIMENTAL DATA ON (HI,xn) REACTIONS. Neubert, W. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Nuclear Reactions). 1972. 24p. Dep. NTIS (U. S. Sales Only).

The experimental peak cross sections and the corresponding ion beam energies are presented for boron, carbon, nitrogen, oxygen, fluorine, neon, phosphorus, and argon induced compound nucleus reactions with following neutron evaporation. The collected data show a decrease of the energies per emitted neutron with increasing mass number. A simple formula for this A-dependence was derived from the presented data. References to the original papers are given, the cutoff data for literature search was March 1972. (auth)

49425 (JUL-811-RX) GAMMA ENERGIES. PART I. NUCLIDES ARRANGED ACCORDING TO ATOMIC NUMBER. SCHEMATIC GAMMA SPECTRA. NUCLIDE TABLE. Meixner, Chr. (Kernforschungsanlage, Juelich (West Germany). Zentralinstitut fuer Reaktorexperimente). Dec 1971. 338p. (In German). Dep. NTIS (U. S. Sales Only).

The characteristic gamma energies of nuclides arranged according to atomic number are compiled in 335 pages. The γ tables are not a compilation of various measurements but contain best values that can be recommended to the user. Therefore, the various measuring data were condensed into a mean value by the reciprocal square of the error method. Also listed are the saturation activities. As neutron flux, a value of 10^{13} cm^{-2} sec^{-1} is assumed. Schematic presentations of nuclides are presented in a simplified fashion containing only the photo- and double escape peaks. The schemes are presented logarithmically in six decades in correspondence with the display of most multichannel analyzers. The tables give decay scheme, half-life, decay product, saturation activity, production method, fission product yield, gamma energy in keV, either absolute or relative intensities, and error of intensities. (H.B.G.)

49426 (JUL-812-RX) GAMMA ENERGIES. PART II. NUCLIDES PRODUCED BY NEUTRONS ARRANGED ACCORDING TO ENERGY (EXCEPT PURE FISSION PRODUCTS). Meixner, Chr. (Kernforschungsanlage, Juelich (West Germany). Zentralinstitut fuer Reaktorexperimente). Dec 1971. 364p. (In German). Dep. NTIS (U. S. Sales Only).

The characteristics of nuclides produced by neutron irradiation with the exception of pure fission products are compiled in 362 pages. Listed are the names of the individual nuclides. Only the 20 most intensive energy lines are given. Energies are indicated with an accuracy of two figures behind the decimal point. Intensities are given in relative values with the strongest line serving as reference of 100. Half-lives are listed with an accuracy of two figures behind the decimal point. If the decay product is radioactive it is also listed. From the saturation activity, it can be immediately determined whether a nuclide is produced by thermal neutrons or by neutrons of a different energy range. (H.B.G.)

49427 (LBL-748) MEASUREMENT OF NUCLEAR EXCITATION FOLLOWING μ^- CAPTURE IN COMPLEX NUCLEI. Kaplan, Selig N. (California Univ., Berkeley. Lawrence Berkeley Lab.). Mar 1972. Contract W-7405-eng-48. 35p. (CONF-710933-6). Dep. NTIS.

From Muon physics conference; Fort Collins, Colo. (6 Sep 1971).

The techniques and results of experiments designed to measure the nuclear excitation spectrum following muon capture are reviewed. Measurements of this excitation are achieved principally by counting or measuring the energy spectrum of emitted neutrons, identifying prompt γ-ray transitions, or identifying resultant radionuclides, with any single measurement giving only a partial picture of the excitation process. Various measurements are compared and where they are complementary, or overlap, they are found to be in good agreement. Special excitation characteristics peculiar to some nuclides (such as considerable charged-particle emission or pronounced resonance characteristics in the neutron spectrum) are observed or inferred consistently by the various measurement techniques. Recent measurements of neutron and γ spectra following muon capture demonstrate the potential importance of muons as a tool for studying giant resonances and shell-model hole levels of nuclei. (auth)

49428 MEASUREMENT OF (n,p), (n,α), AND (n,2n) REACTION CROSS SECTIONS FOR HEAVY NUCLEI. Havlik, E. Acta Phys. Austr.; 34: No. 3, 209-20(1971). (In German).

The total (n,p)-, (n,α)-, and (n,2n)-cross sections were determined for ^{127}I, ^{133}Cs, ^{139}La, ^{140}Ce, ^{141}Pr, ^{144}Nd, ^{156}Gd, ^{158}Gd, ^{160}Gd, ^{159}Tb, ^{160}Dy, ^{164}Dy, and ^{162}Er with the activation method in relation to cross section of the reaction ^{27}Al(n,α)^{24}Na. The reference cross section was assumed to be 111.5 mb ± 1.5%. Each sample was activated between 2 aluminum foils. Neutron irradiation of the samples was performed with a 200 keV cascade accelerator. By means of the ^{3}T(d,n)^{4}He-reaction, the targets yielded neutrons with energy of 14.7 ± 0.15 MeV at the location of the samples. The samples consisted of oxides or carbonates as powders and were used in their natural isotope mixture. Results showed no significant deviation from available data. (tr-auth)

49429 ELASTIC AND INELASTIC SCATTERING OF ALPHA PARTICLES FROM EVEN-MASS MOLYBDENUM ISOTOPES. Matsuda, Kazuhisa; Awaya, Yohko; Nakanishi, Noriyoshi; Takeda, Shigeru (Inst. of Physical and Chemical Research, Saitama, Japan). J. Phys. Soc. Jap.; 33: No. 2, 298-303(Aug 1972).

Elastic and inelastic scatterings of 30.87-MeV alpha particles from ^{92,94,96,98,100}Mo nuclei were studied to determine relative values of β_L for the first 2^+ and 3^- states precisely. Optical-model and DWBA analyses were made. Values of $\beta_L R$ for the 2^+ and 3^- states are compared with those obtained by various reactions. The trend of variation of $\beta_L R$ value with regard to A agrees well for the 2^+ state among various reactions, but some differences are found for the 3^- state. Values of β_3/β_2 obtained are compared with those obtained by the inelastic proton scattering. It is found that the former are smaller than the latter as a whole. (6 figures, 4 tables) (auth)

49430 ENERGY DEPENDENCE OF THE (p,np) REACTION. Hoffmann, G. W. (Univ. of California, Los Angeles); Dunlop, W. H.; Igo, G. J.; (and others). Phys. Lett.; 40B: No. 4, 453-5 (24 Jul 1972).

Excitation functions for the quasi-elastic $(p,n\tilde{p})$ reaction are presented for ^{91}Zr, ^{119}Sn, ^{208}Pb and ^{209}Bi from threshold to 45 MeV. Attempts to fit the data with conventional macroscopic DWBA calculations, using the Becchetti–Greenlees (BG) optical-model parameters, show that for all four nuclei considered an extremely unrealistic but consistent energy dependence is required for the strength of the complex symmetry potential. (auth)

Nuclear Properties and Reactions, 150 ≤ A ≤ 189

Refer also to abstracts 49096, 49344, 49416, 49428, and 49769.

49431 (COO-3255-1) NUCLEAR CHEMISTRY. Progress Report, January 1, 1971–December 31, 1971. Brenner, Daeg S. (Clark Univ., Worcester, Mass. Dept. of Chemistry). 1971. Contract AT(11-1)-3255. 8p. Dep. NTIS.

Research on nuclear spectroscopy of neutron-deficient nuclei in the rare earth region is briefly reported. (J.W.R.)

49432 (LA-4928) EVALUATION OF THE TOTAL CROSS SECTION FOR TUNGSTEN. Devaney, J. J.; Foster, D. G. Jr. (Los Alamos Scientific Lab., N. Mex.). Jun 1972. Contract W-7405-eng-36. 10p. Dep. NTIS.

An evaluation of the smooth neutron total cross section for tungsten between 0.02 and 22 MeV is presented. It is argued that present evidence does not warrant separate treatment for the isotopes except for fluctuations and below 0.7 MeV. (auth)

49433 (NP-19365(Pt.1 and 2)) MIXED N = 6 STATES IN THE RARE EARTH MASS REGION STUDIED BY MEANS OF THE $(^3He,\alpha)$ AND $(\alpha,xn\gamma)$ REACTIONS. Loevhoeiden, G. (Oslo Univ. (Norway). Fysisk Institutt). 1971. 180p. Dep. NTIS (U. S. Sales Only).

Positive-parity states in ^{165,167,169}Er and ^{175,177,179}Hf were studied by means of the $(^3He,\alpha)$ reaction on ^{166,168,170}Er and ^{176,178,180}Hf at a beam energy of 25.5 MeV. The measured cross sections were compared with DWBA optical model calculations. The properties of mixed N = 6 states in the rare earth region are discussed. (J.W.R.)

49434 PERTURBED BETA–GAMMA DIRECTIONAL CORRELATION ^{170}Tm. Tuli, Jagdish Kumar. Bloomington, Ind.; Indiana Univ. (1971). 113p. University Microfilms Order No. 72-18,536.

Thesis.

The beta–gamma directional correlation for the $1^- \xrightarrow{\beta} 2^+ \xrightarrow{\gamma} 0^+$ decay of ^{170}Tm has been measured as function of time spent in the intermediate state. Considerable attenuation due to the finite half-life of the 2+ state has been found. The experiment was performed on a 2% transmission, 1.5% resolution flat-type double-focusing magnetic spectrometer. The focusing characteristics of this spectrometer are very similar to those of $\pi\sqrt{2}$ Siegbahn type of spectrometer. Plastic scintillators were used as detectors for fast response. Standard fast-slow delayed coincidence technique with time-to-pulse-height-converter was used. Overall resolution of the system, i.e., full-width-at half-maximum of the prompt curve, including the time spread in the spectrometer, was 2.25 nsec. Since the resolution is of the same order as the half-life of the intermediate state the integral equation describing the delayed spectrum was unfolded to determine the correlation coefficient A_2 at zero time, i.e., at the time the intermediate state is just formed. The timing spectra were taken at angles of 90° and 180° with respect to the beta direction. Because of the simple exponential form for the attenuation in a liquid source, ^{170}Tm-activity was taken in dilute HCl solution. Although this exponential form is strictly true for γ–γ angular correlations it was assumed, that the same form holds for β–γ directional correlation, too. At energy $W = 1.5\ m_0\ c^2$, A_2 was found to be -0.179 ± 0.018 with attenuation coefficient $G_2(t) = e^{-\mu t}$ where $(1/\mu) = 1.83$ nsec. This corresponds to a time integral anisotropy $A_2 = -0.08$, which is in agreement with the many integral correlation measurements reported in literature. The new result, along with data from longitudinal polarization and shape measurements, was used to determine nuclear matrix elements. In almost all previous matrix element calculations a statistical shape for the beta spectrum has been assumed, but recently in four independent measurements the spectrum has been found to deviate from the allowed shape. In the analysis the data could not be fitted with first forbidden matrix elements alone. A fit was obtained when third forbidden matrix elements, which are of the order of R^2, were included. Third forbidden matrix elements seem to contribute significantly while the first forbidden matrix elements are known to be hindered according to the Alaga selection rules. (Diss. Abstr. Int., B)

49435 NUCLEAR STRUCTURE OF ^{175}Hf, ^{176}Hf, AND ^{180}Hf. Zaitz, Jed Ira. Tallahassee; Florida State Univ. (1971). 125p. University Microfilms Order No. 72-16,600.

Thesis.

The strongly deformed nuclei ^{175}Hf, ^{176}Hf, and ^{180}Hf have been studied by the reactions ^{176}Hf(d,t)^{175}Hf, ^{177}Hf(d,t)^{176}Hf, and ^{179}Hf(d,p)^{180}Hf. These reactions were performed on the Florida State University Super F.N. Tandem Van de Graaff accelerator with the outgoing particles analyzed by means of a Browne–Buechner type broad-range magnetic spectrograph. Twenty-five states associated with two-quasiparticle rotational bands have been identified or tentatively identified in ^{176}Hf and ^{180}Hf; Included are the intrinsic band heads, $6+[514\downarrow + 512\uparrow]$, $3+[514\downarrow - 521\downarrow]$, $4+[514\downarrow + 521\downarrow]$, and $6+[514\downarrow + 523\downarrow]$ in ^{176}Hf and the intrinsic band heads, $4-[624\uparrow - 510\uparrow]$, $5-[624\uparrow + 510\uparrow]$, $6-[624\uparrow + 512\downarrow]$, and $8-[624\uparrow + 503\uparrow]$ in ^{180}Hf. Coriolis mixing calculations have been an important factor in making the state assignments. Fifteen states have been identified in ^{175}Hf. Included are the 9/2+ and 13/2+ members of the 7/2+[633] band, the 3/2- and 7/2- members of the K-2 γ on the 1/2-[521] mixed, 3/2-[521] band and the 7/2- and 9/2- members of the 5/2-[523] band. The Q values for the reactions ^{176}Hf(d,t)^{175}Hf, ^{177}Hf(d,t)^{176}Hf and ^{179}Hf(d,p)^{180}Hf are measured to be -1925 ± 8, -127 ± 11, and 5167 ± 7 keV respectively. (Diss. Abstr. Int., B)

49436 OBSERVATION OF THE SPIN 20 LEVEL IN THE GROUND STATE ROTATIONAL BAND OF ^{158}Dy. Thieberger, P.; Sunyar, A. W.; Rogers, P. C.; (and others) (Brookhaven National Lab., Upton, N. Y.). J. Phys. (Paris), Colloq.; No. 6, 289-90 (1971).

From Symposium on heavy ion reactions and many particle excitations; Saclay, France (8 Sep 1971). See CONF-710961.

The ground state rotational band of ^{158}Dy was populated up to the spin 20 level by means of the ^{150}Nd(^{12}C,4n)^{158}Dy and ^{150}Nd(^{13}C,5n)^{158}Dy reactions and the behavior of the moment of inertia at large rotational frequencies was deduced. (France)

49437 NUCLEAR MATRIX ELEMENTS OF THE 934 keV BETA TRANSITION IN THE DECAY OF ^{186}Re. Narasimha Raju, M. L.; Seshagiri Rao, V.; Sastry, D. L. (Andhra Univ., Waltair, India). Indian J. Pure Appl. Phys.; 9: No. 5, 308-11(May 1971).

The 934-keV β-137-keV γ directional correlation was measured with a conventional slow–fast coincidence scintillation spectrometer. The results are in good agreement with those of the earlier workers. The nuclear matrix element parameters governing the 934-keV beta transition are obtained using the present results, the non-allowed spectral shape reported by S. Andre and P. Liaud [Nucl. Phys., A121(1968), 337], and the circular polarization data of M. Delabaye [Ph.D. thesis, Louisiana University, 1966]. The formalism of P. C. Simms [Phys. Rev., 138(1965), B784] is used in obtaining the matrix elements. The present values of the matrix elements differ considerably from those of Andre and Liaud. The numerical values of the matrix elements suggest that a cancellation among rank-1 matrix elements may be held responsible for the retardation of this beta transition and that Woods–Saxon wave functions are more suitable to describe the states involved in the 934-keV beta decay in ^{186}Re. (5 figures, 4 tables) (auth)

49438 TABLITSY PO VNUTRENNEI KONVERSII γ LUCHEI NA VYSSHIKH OBOLOCHKAKH ATOMA. (Tables for Internal Conversion of γ Rays in the Higher Shells of the Atom). Shidlovskaya, G. (ed.). Minsk; Izdatel'stvo BGU im. V. I. Lenina (1972). 116p.

Theoretical calculated internal conversion coefficients are presented in tabular form, together with basic radial conversion integrals, E0 conversion probabilities, and related quantities. (11 figures, 34 tables, 66 references) (K.S.W.)

49439 EVIDENCE FOR STRONG VARIATION OF THE MOMENT OF INERTIA AT HIGHER ANGULAR MOMENTA IN THE GROUND STATE ROTATIONAL BANDS OF ^{158}Er AND ^{166}Yb. Beuscher, H.; Davidson, W. F.; Lieder, R. M.; Mayer-Boericke, C. (Kerforschungsanlage, Juelich, Ger.). Phys. Lett.; 40B: No. 4, 449-52(24 Jul 1972).

High-spin rotational states in ^{158}Er and ^{166}Yb were studied with the (α,8n) reaction. In the plot of the moment of inertia associated with these states versus the square of the rotational frequency, S-shaped curves were obtained. (auth)

Nuclear Properties and Reactions, 190 ≤ A ≤ 219

Refer also to abstracts 47864, 48883, 49096, 49345, 49354, 49397, 49423, 49430, 49438, and 49450.

49440 (DESY–72/28) PHOTON INDUCED NUCLEAR REACTIONS ABOVE 1 GeV. III. FISSION IN GOLD AND LEAD. Kroon, I.; Forkman, B. (Deutsches Elektronen-Synchrotron, Hamburg (West Germany)). Jun 1972. 16p. Dep. NTIS (U. S. Sales Only).

The photofission cross section per equivalent quantum and the forward-to-backward ratios of gold and lead have been measured in the bremsstrahlung energy range 1.0 – 7.4 GeV using glass detectors. The experimental data are analyzed using data from an earlier lower energy experiment done at Lund with the same experimental technique. It is verified that the fission cross sections for the two target elements are almost constant above 1 GeV. From the moderate dependence of the forward-to-backward ratio on photon energy it is concluded that the excitation energy of the fissioning nucleus and the momentum transferred to it are rather independent of photon energy. The forward momentum deposited at the instant of fission is shown to increase only slowly, decreasing from 40% to 10% of the compound nucleus value in the energy interval studied. (auth)

49441 (RLO–1759-28) FISSION STUDIES ON ELEMENTS BELOW POLONIUM. Progress Report, January 1, 1972–June 30, 1972. Neuzil, Edward F. (Western Washington State Coll., Bellingham). 1972. Contract AT(45-1)-1759. 7p. Dep. NTIS.

Research on charged-particle induced fission on elements below polonium is briefly reported. (J.W.R.)

49442 COMPOUND PARTICLE–CORE COUPLED STATES AND DIRECT NUCLEAR PROCESSES. Ayoub, E. E.; Ascuitto, R. J.; Bromley, D. A. (Yale Univ., New Haven). Phys. Rev. Lett.; 29: No. 3, 182-5(17 Jul 1972).

A detailed study of the inelastic scattering reaction ^{206}Pb(p,p′) ^{206}Pb*(2_1^+) for incident proton energies in the range from 14.2 to 17.3 MeV is presented. It has been found possible to reproduce the experimental results quantitatively using a theoretical analysis incorporating a number of resonant compounds, as well as direct inelastic, scattering amplitudes. Interference effects play an important role and predictions of shell and weak-coupling models are found to be in excellent agreement with the experimental data. (auth)

49443 EXCITED LEVELS IN N = 126 ISOTOPES STUDIED BY (HI,xnγ) REACTIONS. Maier, K. H.; Leigh, H. R.; Puehlhofer, F.; Diamond, R. M. (Univ. of California, Berkeley). J. Phys. (Paris), Colloq.; No. 6, 221-2(1971).

From Symposium on heavy ion reactions and many particle excitations; Saclay, France (8 Sep 1971). See CONF-710961.

Excited levels in the N = 126 nuclei ^{211}At, ^{212}Rn, ^{213}Fr, and ^{214}Ra were studied by in-beam γ-spectroscopy with (HI,xnγ)-reactions, and spins up to 39/2 were observed. Magnetic moments, B(E2) and B(E3) values were measured for some of these levels. The electromagnetic properties are discussed. (France)

49444 PARTICULAR MULTINUCLEON TRANSFER PROCESS IN THE ^{7}Li + ^{197}Au REACTION FOR GRAZING CONDITIONS. Quebert, J. L.; Sztark, H. (Bordeaux Univ., Bradignan, France). J. Phys. (Paris), Colloq.; No. 6, 255-8(1971).

From Symposium on heavy ion reactions and many particle excitations; Saclay, France (8 Sep 1971). See CONF-710961.

The heavy emission of alpha particles and tritons in the ^{7}Li + ^{197}Au reaction cannot be accounted for by projectile break-up. The particles are emitted from a quasi-bound rotating system formed by the target and the less-bound cluster-structure of the projectile. This mechanism occurs when the projectile is in the vicinity of the target and has a negligible relative velocity. (France)

Nuclear Properties and Reactions, A ≥ 220

Refer also to abstracts 47864, 49096, 49416, 49438, and 49672.

49445 (LIB/Trans–380) RADIATIVE CAPTURE OF NEUTRONS BY ^{232}Th NUCLEUS IN THE ENERGY RANGE 0.01 TO 15 MeV. Davletshin, A. N.; Tolstikov, V. A.; Abramov, A. I. (Gosudarstvennyi Komitet po Ispol'zovaniyu Atomnoi Energii SSSR, Obninsk. Fiziko-Energeticheskii Institut). Translated for Australian Atomic Energy Commission Research Establishment, Lucas Heights, from report FEI–234. 64p. INIS.

A critical examination of the experimental measurements of the ^{232}Th(n,γ) reaction for neutrons with energies above 10 keV is made. In a number of cases the results of the measurements have been renormalized to values of the cross sections which are currently accepted as reference. A procedure for averaging cross sections is proposed which takes into account the form of the dependence of the cross section on energy. Based on the analysis of data from several authors, a recommended curve is given for the dependence of ^{232}Th(n,γ) on neutron energies in the interval 0.01 to 14.5 MeV. The numerical data used for renormalization and averaging are quoted in full. Also quoted is the recommended value of the radiative capture cross section of ^{232}Th for thermal neutrons. (3 figures, 15 tables) (INIS) (auth)

49446 (BARC–584) ^{99}Mo FISSION YIELD IN THE THERMAL NEUTRON-INDUCED FISSION OF ^{239}Pu AND ^{235}U. Jain, H. C.; Ramaniah, M. V. (Bhabha Atomic Research Centre, Bombay (India)). 1971. 21p. Dep. NTIS (U. S. Sales Only).

The large discrepancies in the earlier reported values of ^{99}Mo fission yield in the thermal neutron-induced fission of ^{239}Pu and the difficulty in selecting a particular value for the ^{99}Mo yield while determining the fission yields of many other nuclides in the neutron-induced fission of ^{239}Pu using gamma-ray spectrometry with a Ge(Li) detector led to a detailed investigation and its absolute measurement. The disintegration rate of ^{99}Mo was determined using the recently published work. The number of fissions was calculated by irradiating accurately known and isotopically analyzed amounts of ^{239}Pu and ^{235}U and monitoring the neutron flux using the ^{59}Co(n,γ)^{60}Co reaction. The modified "comparison method" gave a value of 6.79 ± 0.15 for the ^{99}Mo fission yield in the thermal neutron-induced fission of ^{239}Pu. The "absolute method" gave a value of 6.66 ± 0.07 and 6.06 ± 0.16 in the case of ^{239}Pu and ^{235}U fission respectively. The value 6.06 ± 0.16 obtained for ^{99}Mo yield in ^{235}U fission by the "absolute method" in the same series of experiments indicates the accuracy of the present measurements since this value compares reasonably well with 6.16 which is the accepted literature value. (auth)

49447 (DESY–72/29) PHOTON INDUCED NUCLEAR REACTIONS ABOVE 1 GeV. IV. MASS DISTRIBUTION IN THE 6.00 GeV BREMSSTRAHLUNG INDUCED FISSION OF NATURAL URANIUM. Schroeder, B. (Deutsches Elektronen-Synchrotron, Hamburg (West Germany)). Jun 1972. 22p. Dep. NTIS (U. S. Sales Only).

The mass distribution in the 6.00 GeV bremsstrahlung induced fission of natural uranium has been analyzed. The measured yields are shown to correspond to at least 90 per cent of the chain yields. The results are compared with other experiments. The mass distribution curve has been decomposed into two distributions, one symmetric and one asymmetric. Finally the peak-to-valley ratio obtained is compared with results at lower irradiation energies. Good agreement is found and from the results above 1 GeV it is deduced that the total fission cross section for ^{238}U decreases rapidly with energy. (auth)

49448 (LUNP–7206) YIELDS OF SOME PHOTOFISSION PRODUCTS FROM ^{238}U. Schroeder, B.; Nordgren, B.; Alm, A. (Lund Univ. (Sweden). Dept. of Physics. Lund Inst. of Tech. (Sweden). Dept. of Nuclear Physics). Mar 1972. 25p. Dep. NTIS (U. S. Sales Only).

The yields of some photofission products and of the (γ,n) reaction from ^{238}U have been measured in the energy range 100 to 760 MeV. Average cross sections are deduced and compared to calculations. It is found that variations in the average cross sections can be explained by an increasing probability of the formation of highly-excited post-cascade nuclides with increasing photon energy. (auth) (Sweden)

49449 (RLO–1388-175) ENERGY DEPENDENCE OF THE FISSIONABILITY OF NEPTUNIUM ISOTOPES AND THE LEVEL DENSITY OF HIGHLY DEFORMED NUCLEI. Bishop, C. J.; Halpern, I.; Shaw, R. W. Jr.; Vandenbosch, R. (Washington Univ., Seattle). 1972. 51p. Dep. NTIS.

The relative probability, Γ_n/Γ_f, of neutron evaporation and fission was determined for neptunium isotopes produced in bombardments of ^{238}U with protons of energy up to 22 MeV. The measurement involved the comparison of the numbers of neutrons emitted at 0° to fission fragments with those emitted at 90°. The observations are incompatible with the statistical theory expressions for Γ_n/Γ_f using the Fermi Gas expression for nuclear level densities with deformation-independent values for the level density parameter, a. They can be brought into accord with the theory if the value of a at the saddle point distortion is 10 to 15% larger than that near the normal ground state. A difference of about this magnitude is suggested by microscopic calculations of the relevant level densities when they are allowed to include single particle and pairing effects. (auth)

49450 (UCRL-51232) NEUTRON SPECTRA EMITTED BY ^{239}Pu, ^{238}U, ^{235}U, Pb, Nb, Ni, Al, AND C IRRADIATED BY 14-MeV NEUTRONS. Kammerdiener, John Luther (California Univ., Livermore. Lawrence Livermore Lab.). 5 Jul 1972. Contract W-7405-eng-48. 221p. Dep. NTIS.
Thesis.

The ICT time-of-flight facility at Lawrence Livermore Laboratory was used to measure the elastic and inelastic differential scattering cross sections of nominally 14 MeV neutrons from targets of ^{239}Pu, ^{238}U, ^{235}U, Pb, Nb, Ni, Fe, Al, and C. Ring geometry and time-of-flight were used to measure scattered neutrons over four decades of energy between 10 keV and 14 MeV at an energy resolution of $E^{3/2}/200$ (MeV). Measurements were made in 5 degree increments between 20 and 160 degrees (lab) with an angular resolution of 2 degrees. An Ne 213 scintillation detector was used to detect scattered neutrons with energy greater than one MeV. Pulse shape discrimination circuitry allowed simultaneous recording of both neutron and gamma (pulse height spectrum) data with low background. A ^{6}Li-glass detector was used for measurements below 1 MeV. Statistical uncertainties are less than 10%. Scattering from the 1 cm × 2 cm × 22 cm ring targets was corrected for multiple scattering, flux attenuation, isotopic abundance by Monte Carlo calculations. The 2^+ levels of Fe and Ni were clearly resolved but 3^- levels expected at similar excitation energies in ^{239}Pu, ^{238}U, ^{235}U were not seen. (auth)

49451 NUCLEAR-CHARGE AND MASS DISTRIBUTION IN FISSION: YIELDS AND GENETIC HISTORIES OF ^{128}Sb, ^{129}Sb, AND ^{130}Sb FROM THERMAL-NEUTRON FISSION OF ^{235}U. Fowler, Malcolm McFarland. St. Louis; Washington Univ. (1972). 149p. University Microfilms Order No. 72-17,951.
Thesis.

The fractional independent yields of ^{128}Sb, ^{129}Sb, and ^{130}Sb, and the cumulative yield of ^{130}Sn from thermal-neutron induced fission of ^{235}U were measured. The independent yields of the antimony members of the decay chains and the fraction of the antimony formed by beta decay were measured by making timed chemical separations of tin and antimony. Proportional gas-flow beta counters were used for measurement of the yield of ^{129}Sb. A technique for making yield measurements using a Ge(Li) detector was developed and applied to the measurement of the ^{128}Sb and ^{130}Sb yields. The fraction of ^{128}Sn and ^{130}Sn decaying to the two isomers of each of the corresponding daughters was determined. The fraction of ^{129}Sb formed from each of the two ^{129}Sn isomers by beta decay was also measured. The chain yields of the mass-128 and -130 decay chains were calculated using the measured yields of the tin and antimony members of the decay chains and estimated tellurium yields. The yields of ^{128}Sb and ^{130}Sb were combined with previously reported independent yields of ^{128}I and ^{130}I to determine nuclear charge dispersion parameters for each mass. The width, σ, of the assumed Gaussian dispersion curve, and the value of Z at the maximum of each curve, Z_p were calculated and compared with the extrapolated values used to estimate "normal" yields. The fractional independent yields of ^{128}Sb, ^{129}Sb, and ^{130}Sb were found to be somewhat lower than estimated values. Because the reported value for the yield of ^{128}I is higher than estimated for a normal yield, the charge dispersion parameters calculated for the mass-128 decay chain using the reported yield do not agree with extrapolated values. The large fractional cumulative yields of the tin members of the decay chains investigated may be indicative of preferential formation of tin due to closure of the 50-proton shell. Fractional cumulative yields of the indium precursors of the tin need to be determined to verify this. The half-lives of ^{129}Sb and ^{130}Sn and the isomers of ^{128}Sb, ^{129}Sn, and ^{130}Sb were measured. Half-life determinations were made by following the decay of beta activity or by growth and decay of gamma-ray peak areas with time. The measured values were averaged with other recent determinations, where available, to get overall most reliable values which were then used in the calculations. (Diss. Abstr. Int., B)

49452 DECAY OF ^{239}Am. Post, J. C.; Aten, A. H. W. Jr. (Instituut voor Kernphysisch Onderzoek, Amsterdam). Radiochim. Acta; 17: No. 2, 117-18(Jul 1972).

^{239}Am was separated from an irradiated ^{237}Np target. Its fairly long half-life allowed further purification steps, and these are described in some detail. The purified source obtained by this method, which takes about 5 h and gives an overall yield of about 50%, contains no detectable fission activities. Gamma spectra from the electron-capture decay of ^{239}Am were measured by using a Ge(Li) detector, and a decay scheme was constructed. (1 figure, 2 tables) (R.W.R.)

Nuclear Theory

Refer also to abstracts 48578, 49037, 49227, 49388, and 49415.

49453 (CEA-N-1327(Pt.7)) SAPRISTI-CODE. NUCLEAR REACTIONS BETWEEN LIGHT NUCLEI. Volume V. (Commissariat a l'Energie Atomique, Paris (France)). [nd]. 93p. (In French). Dep. NTIS (U. S. Sales Only).

A list of 250 references (from 2500 to 2749) of review articles dealing with nuclear reactions between light nuclei is presented. The principal information is given for each reaction. (France)

49454 (CEA-N-1327(Pt.8)) SAPRISTI-CODE: NUCLEAR REACTIONS BETWEEN LIGHT NUCLEI. REACTION TABLE. (Commissariat a l'Energie Atomique, Paris (France)). [nd]. 96p. (In French). Dep. NTIS (U. S. Sales Only).

A table of nuclear reactions between light nuclei is presented. The outgoing particles and the energies are given. The reference numbers refer to the SAPRISTI code bibliography. (France)

49455 (CEA-N-1532(E)) COMPARISON OF SPHERICAL OPTICAL MODEL CODES AND PROPOSITION OF STANDARD VALUES FOR TESTING A CODE. Kikuchi, Yasuyuki (Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires). Mar 1972. 29p. Dep. NTIS (U. S. Sales Only).

In order to examine the reliability of the results calculated with different spherical optical model codes and to find the optimum numerical integration condition, six codes (MAGALI, GENOA, KOUAC, ABACUS-2, JUPITOR and ECIS-70) were compared with the same optical model parameters for neutron energies of 0.6, 4.75 and 14.1 MeV. The number of meshes in the numerical integration should be such as to optimize both the truncation error and the rounding off error. The best value should fall between 100 and 200 for a code with single precision in IBM-360. An insufficient matching radius can cause considerable errors (as in the case of GENOA). Slight errors in the values of the physical constants used in the program, such as the neutron mass and the conversion constant between energy and wave length can lead to large errors in the results (as in the case of ABACUS-2). Taking these conditions into consideration, good agreement was found in the results of the six codes. The present results are proposed as standard values to check other codes. (France)

49456 (CONF-720607-20) GENERATION OF KAPUR-PEIERLS PARAMETERS FROM R-MATRIX PARAMETERS BY THE INVARIANT IMBEDDING TECHNIQUES. Perez, R. B.; de Saussure, G. (Oak Ridge National Lab., Tenn.). 1969. 3p. Dep. NTIS.

From eighteenth annual American Nuclear Society conference; Las Vegas, NV. (18 Jun 1972).

A method for the generation of Kapur-Peierls parameters for neutron resonances from R-matrix parameters is presented. The method makes use of the invariant imbedding technique and does not involve iterative techniques or matrix inversion. (J.W.R.)

49457 (COO-3001-13) ALPHA-DECAY WIDTHS OF ^{20}Ne. Arima, A. (State Univ. of New York, Stony Brook. Dept. of Physics); Yoshida, S. (Rutgers-The State Univ., New Brunswick, N. J. Dept. of Physics). 1971. 12p. Dep. NTIS.

Based on harmonic oscillator shell model wave functions, α-widths are calculated for the ^{20}Ne ground state band and other levels. The SU_3 shell model wave function is rewritten as an α-cluster form and the tail of the relative ^{16}O and α cluster wave function is improved by introducing a Woods-Saxon type effective potential. The calculated results are in good agreement with experimental data, and detailed features are discussed. (auth)

49458 (COO-3235-12) CORRELATION FUNCTION FOR ISOVECTOR AMPLITUDES IN NUCLEI. Kao, Ellen Ih-liang; Fallieros, S. (Brown Univ., Providence, R. I. Dept. of Physics). 1972. Contract AT(11-1)-3235. 1p. (CONF-720907-2). Dep. NTIS.

From International conference on nuclear structure studies using electron scattering and photoreaction; Sendai, Japan (12 Sep 1972).

The isovector and isotensor coefficients in the correlation function are discussed. (J.W.R.)

49459 (COO—3235-13) FIXED-PARITY SUM RULES FOR INELASTIC FORM FACTORS. Deal, T. J.; Fallieros, S. (Brown Univ., Providence, R. I. Dept. of Physics). 1972. 1p. (CONF-720907—1). Dep. NTIS.

From International conference on nuclear structure studies using electron scattering and photoreaction; Sendai, Japan (12 Sep 1972).

Sum rules for scattering form factors are presented which involve only states of a given parity. The usefulness of such expressions is related to the fact that the distribution of strength is often dominated by collective giant doorway excitations whose modes depend on parity more than angular momentum. (J.W.R.)

49460 (HMI-B—121) NUCLEAR REACTIONS WITH HEAVY IONS. Theoretical Seminar in Summer Semester 1971. Eichler, J.; Frahn, W. E.; Krappe, H. J.; Lipperheide, R.; Moehring, K.; Sichelschmidt, F.; Wille, U. (Hahn-Meitner-Institut fuer Kernforschung, Berlin (West Germany)). May 1972. 331p. (In German). Dep. NTIS (U. S. Sales Only).

Separate abstracts were prepared for each of the eight lectures included. (J.W.R.)

For abstracts of individual papers see: 49461—49468.

49461 (HMI-B—121, pp I.1-12) INTRODUCTION AND SYNOPSIS. Lipperheide, R. May 1972. (In German).

In Nuclear reactions with heavy ions.

Presented is the introductory lecture to a seminar on the theory of nuclear reactions with heavy ions which was held at the Hahn-Meitner institute in 1971. Heavy ion physics is defined as that field which describes all nuclear reactions resulting from projectiles with mass numbers of 6 or higher. General characteristics of such reactions and projectiles are compiled. Five major themes are presented. Discussed are: elastic and inelastic scattering; direct transfer reactions; compound nuclei reactions; fission and heavy ion reactions; and four-particle correlations in nuclei. (H.B.G.)

49462 (HMI-B—121, pp II.1-79) SCATTERING OF HEAVY IONS. Frahn, W. E. May 1972. (In German).

In Nuclear reactions with heavy ions.

Discussed is elastic scattering from an experimental and theoretical point of view. The physical nature is essentially a diffraction scattering whereby the diffractive cross sections are independent of structure and yield information only about global interactions. The nuclear structure exerts its influence through deviation of the normal diffraction behavior. Also discussed is non-elastic scattering. This type of scattering yields spectroscopic information about the dynamic deformation of excited states. In addition, heavy ions preferentially excite collective states with high spins. Finally discussed are transfer processes and elastic scattering. (H.B.G.)

49463 (HMI-B—121, pp III.1-42) TRANSFER REACTIONS A. (Transfer Above the Coulomb Barrier). Sichelschmidt, F. May 1972. (In German).

In Nuclear reactions with heavy ions.

Discussed are reaction mechanisms and the distorted wave born approximation (DWBA). Under DWBA are treated the deviation of amplitude; approximation calculations of the cinematic component of the amplitude; various methods for evaluation of the cinematic component of the amplitude; recoil and finite-range effects; fixed-range effects; and exact computations. Under additional effects is treated core excitation. (H.B.G.)

49464 (HMI-B—121, pp IV.1-34) TRANSFER REACTIONS B. (Sub-Coulomb Transfer). Moehring, K. May 1972. (In German).

In Nuclear reactions with heavy ions.

Treated first is the semiclassical theory of sub-Coulomb transfer. Subsequently discussed is the transfer theory which, at the present time, is predominantly based on the distorted wave born approximation and on the Coulomb wave born approximation, respectively. Also treated is an alternative method that uses Greider's t-matrix approach. In contrast to the transfer induced by heavy ions at high energies, the sub-Coulomb transfer is largely free of uncertainties, such as optical potentials, and the DWBA can be formulated without restraint. Thus, mathematical expressions are obtained which can be handled numerically without the need for zero range approximation. (H.B.G.)

49465 (HMI-B—121, pp V.1-31) COMPOUND-NUCLEUS REACTIONS A. (Statistical Theory). Lipperheide, R. May 1972. (In German).

In Nuclear reactions with heavy ions.

The statistical theory of compound reactions is discussed first. Then, general mathematical expressions are derived for cross sections in the statistical theory and various approximations are discussed. Subsequently treated are level densities, transmission coefficients, and spin effects. Also discussed are extensions of the compound theory which concern themselves with pre-compound processes as well as with mixtures of compound nuclear and direct processes. Application in details are treated in a final chapter. (H.B.G.)

49466 (HMI-B—121, pp VI.1-43) COMPOUND-NUCLEUS REACTIONS B. (Application of the Statistical Theory to Heavy-Ion Reactions). Wille, U. May 1972. (In German).

In Nuclear reactions with heavy ions.

Various applications of the general statistical theory of heavy ion-induced compound processes are discussed and computations, that are based on special approximations and on models, are compared with experimental data. For the assessment of Y-rast energies, various suitable models are analyzed. Subsequently, the effect of Y-rast states is discussed with respect to formation and decay of compound nuclei during heavy ion reactions. The results of computations derived from models are then compared with experimental data. (H.B.G.)

49467 (HMI-B—121, pp VII.1-41) FISSION AND HEAVY-ION REACTIONS. Krappe, H. J. May 1972. (In German).

In Nuclear reactions with heavy ions.

Described are attempts at using concepts of fission theory for the description of certain heavy ion reactions. Intentionally, the theory of "first principles" is not applied. The central concept of energy planes is introduced with respect to nuclear fission theory. Then, the theory of pure Coulomb scattering is presented especially from the aspect of deformation of the collision partners in the entrance channel. Another section treats models which describe heavy ion reactions at energies above the Coulomb threshold. These models are used first for the treatment of elastic scattering and, then, for reactions with particle exchange. (H.B.G.)

49468 (HMI-B—121, pp VIII.1-37) FOUR-PARTICLE CORRELATIONS IN NUCLEI. Eichler, J. May 1972. (In German).

In Nuclear reactions with heavy ions.

Under alpha clusters are discussed the resonating group method, rigid cluster systems, the shell model as boundary condition, and spin and parity. Under quartet structure are treated the stretch scheme, the quadrupole—quadrupole force, mass formulas, rotons, and experimental evidence. Under quadrupole model is presented construction of the basis, effective quadrupole force, analogy to the seniority scheme, results, and exchange of both pairs and quadruples in heavy ion reactions. The survey shows that the theory of four-particle correlations is in many respects not refined enough as yet. All attempts at simplification should avoid concessions with respect to one point: the Pauli principle must be strictly retained. (H.B.G.)

49469 (INP—798) PROTON INDUCED COHERENT PRODUCTION OF PARTICLES IN NUCLEI. Lesniak, H.; Lesniak, L. (Institute of Nuclear Physics, Krakow (Poland)). Mar 1972. 16p. Dep. NTIS (U. S. Sales Only).

The energy dependence of three-prong production cross section induced by high-energy protons in nuclei is studied. The nuclear emulsion results are in agreement with predictions of the optical model. (auth)

49470 (JINR—E4-6487) MAGNETIC MOMENTS OF THE HIGHLY EXCITED STATES OF ATOMIC NUCLEI. Soloviev, V. G.; Voronov, V. V. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics). 1972. 15p. Dep. NTIS (U. S. Sales Only).

Formulas for the magnetic moments of the highly excited states of atomic nuclei are derived on the basis of the semimicroscopic approach. It is shown that the magnetic moments are expressed in terms of all the components of the wave functions of highly excited states. According to a rough estimation, the magnetic moments of intermediate excitation states and highly excited states, including neutron resonances, must be equal, in the order of magnitude, to the single-particle values. The situation with the magnetic moments differs essentially from that with the probabilities of the E1 and M1 transitions from highly excited to low-lying states which are smaller than the single particle values by a factor of $10^5 - 10^7$. The theoretical results are in agreement with the available experimental data on the magnetic moments of neutron resonances. (auth)

49471 (JINR—E4-6563) NEW APPROACH TO THE STUDY OF THE STRUCTURE OF NEUTRON RESONANCES. Solov'ev,

V. G. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics). 1972. 28p. Dep. NTIS (U. S. Sales Only).

The structure of neutron resonances is considered on the basis of the operator form of the wave functions of highly excited states. The one- and two-quasiparticle components of the wave functions are found to be $10^{-6} - 10^{-9}$ from the experimental data on reduced neutron and radiative widths. The magnetic moments of neutron resonances are calculated. It is shown that they must be close to the single-particle values. (auth)

49472 (NP–19333) APPROACH TO THE THEORY OF UNSTABLE STATES. Agodi, A.; Baldo, M.; Recami, E. (Catania Univ. (Italy). Istituto di Fisica. Istituto Nazionale di Fisica Nucleare, Catania (Italy)). Jan 1972. 31p. Dep. NTIS (U. S. Sales Only).

A new method introduced by one of us (A.A.) has been followed for analyzing the effects produced by an internal (virtual) state $|\phi>$ on the transition amplitudes. In particular, for singling out the necessary conditions for $|\phi>$ being connected with a resonance in the cross section. In the case of potential scattering, for instance, the resonance determination by means of the Kapur & Peierls method is shown to be equivalent to the determination of the spectral function of a quasi self-adjoint operator (whose anti-Hermitian part is defined by means of a single state). In general, by associating unstable states with the eigenvalues of quasi self-adjoint Hamiltonians, a new definition of resonance may be given. The application of this method to the study of resonances related to a spherical-well potential seems to confirm the validity of the method. (auth)

49473 (ORNL-TM-3896) FOLDED FORM FACTORS AND THE CODE FOLD. Bell, W. K.; Satchler, G. R. (Oak Ridge National Lab., Tenn.). Aug 1972. Contract W-7405-eng-26. 8p. Dep. NTIS.

A FORTRAN code, FOLD, was written for the IBM 360/75 and /91 to computer form factors, h(r), by folding together two functions, f(t) and g(s), where t = r-s. The f and g may be chosen from 10 analytic forms. The h(r) may be punched on cards if required. (auth)

49474 (RLO-1388-636) PROGRAM B: THEORETICAL NUCLEAR PHYSICS PROGRAM. Progress Report, October 1, 1971–September 30, 1972. (Washington Univ., Seattle. Dept. of Physics). 1972. Contract AT(45-1)-1388. 27p. Dep. NTIS.

Research in the theoretical nuclear physics program at the University of Washington for the year ending Sept. 30, 1972 is briefly reported. The research included nuclear reactions, nuclear structure, and symmetries; quantum statistical mechanics and many body problems; field theory and elementary particles; atomic and molecular physics; and general theory. (J.W.R.)

49475 π^- CONDENSATE IN DENSE NUCLEAR MATTER. Scalapino, D. J. (Univ. of California, Santa Barbara). Phys. Rev. Lett.; 29: No. 6, 386-8(7 Aug 1972).

Sawyer has proposed a variational ground state for superdense nuclear matter which contains a coherent admixture of approximately equal numbers of protons, neutrons, and π^- particles. Here this problem is investigated by introducing a self-consistent mean π^- field. At a critical baryon density the normal ground state becomes unstable with respect to the formation of an infinitesimal π^- condensate. (auth)

49476 INTERACTION OF HIGH ENERGY PARTICLES WITH NUCLEI. Moniz, Ernest Jeffrey. Stanford, Calif.; Stanford Univ. (1972). 238p. University Microfilms Order No. 72-16,759.

Thesis.

A theory of high energy particle-nuclear interactions requires a description both of the target structure and of the projectile-nucleon interaction. Consequently, such processes offer the opportunity for extracting new information on the dynamics of nuclear systems (when the elementary interactions are known) and on hadron-nucleon scattering amplitudes (when the nucleus is treated as a target with known properties). These possibilities are explored in high energy coherent and incoherent nuclear reactions. Hadron elastic scattering from nuclei is remarkably well described by the simple Glauber optical potential $2m\, V_{opt}(\underset{\sim}{x}) = -4\pi A\, \rho(\underset{\sim}{x})\, f(0)$, where m is the projectile mass, $\rho(\underset{\sim}{x})$ is the nuclear single-particle density, and f(0) is the measured forward amplitude for elastic projectile-nucleon scattering. This assumes that the nuclear target can be described by the independent particle model and that the elementary interactions can be described by free-space amplitudes even in the many-body system. The goal is a consistent theory of corrections to the lowest-order Glauber result. First, the effects of doing a better job on the nuclear physics are examined within the framework of Glauber multiple-scattering theory: A realistic two-body density for the nuclear medium is computed and the resultant modification of the optical potential is evaluated. Second, off-shell effects are studied for a model of nonlocal, separable projectile-nucleon interactions. It is found that both effects are small, and this provides a theoretical justification for Glauber theory. On the other hand, these leading correction terms are important if one hopes to use nuclei as "laboratories" for studying hadron-nucleon interactions at the ten percent level. The treatment of coherent processes includes an extension of the Glauber multiple-scattering formalism to inelastic coherent reactions, such that higher order nuclear physics corrections can be consistently evaluated. These results are applied in a detailed study of high energy photonuclear reactions. In the second part of the dissertation, the systematics of "deep inelastic" electron scattering from complex nuclei is examined, within the framework of the nuclear Fermi gas model. A first attempt is made to compute the cross section in the region of electron energy loss corresponding to excitation of the 3-3 resonance by assuming that quasi-free N^* excitation dominates single-pion production. The quasielastic scattering is also calculated, the idea being to use the knowledge of the quasielastic peak to "remove" the nuclear physics and then to learn something about isobar propagation. These calculations retain relativistic kinematics for the recoiling particle and the full relativistic electromagnetic vertex. It is found that the Fermi gas calculation describes the quasielastic peak extremely well for large momentum transfers, which provides for the first time a direct, dynamical determination of the nuclear Fermi momentum as a function of atomic number. (Diss. Abstr. Int., B)

49477 NOTE ON ATOMIC NUMBERS AND MASS NUMBERS. Miyake, Ryoichi; Yajima, Hisa (Chiba Univ., Japan). Nippon Kagaku Kaishi; No. 5, 899-907(May 1972). (In Japanese).

Atomic masses (A) of the most stable nuclides are generally found by linear summations of (p – n) for nuclides whose atomic numbers (Z) are below 30 and p – n – n for those above 30 Z nuclides. Binding energies (b.e.) are calculated by this method and additions of Δb.e./ΔZ to b.e. of deuterium or tritium, according to whether Z are even or odd, give those of the first 20 Z nuclides. ΔB.e./ΔZ average 18 MeV below 20 Z and 20 MeV above 25 Z, which approximately corresponds with binding energies per proton (b.e.p.p.). Binding energies per nucleon (b.e.p.n.) bear the maximum value around 25 Z, since b.e.p.n. = b.e.p.n. Z/A. Neutrons increase by additional formulas: 2n are required to combine with every accumulation of 10 p – n between 20 Z and 40 Z nuclear groupings, while neutrons, accumulated beside p – n during a compilation of 10 nuclides, are not transferred to the next coming 10 Z group before 50 Z is completed. These formulas are tested for several features in stabile nuclides (magic numbers and others). On the basis of these findings the alpha particle theory is hardly acceptable and the coefficient of surface tension in the Bethe equation is found to be overestimated. (auth)

49478 SYMPOSIUM ON HEAVY ION REACTIONS AND MANY PARTICLE EXCITATIONS, SACLAY, FRANCE, SEPTEMBER 8–14, 1971. J. Phys. (Paris), Colloq.; No. 6, 1-312(1971). (In French and English). (CONF-710961).

Seventy one papers were presented at the conference and each of them was abstracted separately. They report studies on the nuclear structure of intermediate mass nuclei using transfer reactions induced by heavy ion beams. (France)

For abstracts of individual papers see: 49356–49386, 49395–49402, 49406–49414, 49418, 49436, 49443, 49444, and 49479–49497.

49479 INTRODUCTORY CONFERENCE. Messiah, A. (CEN de Saclay, Gif-sur-Yvette, France). J. Phys. (Paris), Colloq.; No. 6, 1-4(1971). (In French).

From Symposium on heavy ion reactions and many particle excitations; Saclay, France (8 Sep 1971). See CONF-710961.

After some general comments on heavy ion physics, the model of supermultiplets is mentioned as the oldest model leading to a quartet structure in nuclei. The model is briefly outlined and the very surprising success of its prevision on ground state binding energies is discussed. (France)

49480 NUCLEAR QUARTETING. Gillet, V. (CEN de Saclay, Gif-sur-Yvette, France). J. Phys. (Paris), Colloq.; No. 6, 17-23(1971).

From Symposium on heavy ion reactions and many particle excitations; Saclay, France (8 Sep 1971). See CONF-710961.

4-nucleon spectra are discussed in terms of pairing and quarteting effects. It is then shown that in a single large j-shell the loss of angular overlap between nucleon orbitals due to the exclusion principle entails the existence of 2 proton–2 neutron structures or quartets mutually weakly interacting. Estimates of the effect are extracted from the nuclear mass table. The consequences of quarteting for the excited states of medium and heavy nuclei are finally discussed. (France)

49481 ANTISYMMETRIZED WEAK COUPLING SCHEME IN SHELL MODEL CALCULATIONS. Wong, S. K. M.; Zuker, A. P. (CEN de Saclay, Gif-sur-Yvette, France). J. Phys. (Paris), Colloq.; No. 6, 51-5(1971).

From Symposium on heavy ion reactions and many particle excitations; Saclay, France (8 Sep 1971). See CONF-710961.

Shell model calculations were carried out in the framework of an antisymmetrized weak coupling. The dimensions of the matrices were considerably reduced and the interpretation of the results was simplified. The results were compared with experimental data. (France)

49482 DEFORMED STRUCTURES AND ALPHA-PARTICLE DESCRIPTION OF LIGHT NUCLEI. Abgrall, Y. (Univ., Bordeaux); Caurier, E. J. Phys. (Paris), Colloq.; No. 6, 63-8(1971).

From Symposium on heavy ion reactions and many particle excitations; Saclay, France (8 Sep 1971). See CONF-710961.

The microscopic α-cluster model of Brink and Marguenau was used to study light 4n nuclei and was compared with Hartree–Fock calculations for ^{8}Be, ^{12}C, ^{16}O, and ^{20}Ne nuclei. This model gives a better description of the nuclei and the deformed structure appear quite clearly. However, for ^{24}Mg and ^{28}Si a discrepancy is observed between the results of these two models. (France)

49483 SEMICLASSICAL TREATMENT OF HEAVY ION REACTIONS. Winther, A. (Niels Bohr Institutet, Copenhagen). J. Phys. (Paris), Colloq.; No. 6, 83-6(1971).

From Symposium on heavy ion reactions and many particle excitations; Saclay, France (8 Sep 1971). See CONF-710961.

A semiclassical theory of transfer reactions is presented which includes the main recoil effects due to the exchange of energy, mass, and charge. The equations of motion contain the effects of non-orthogonality of the wave functions and describe the excitation and transfer processes to any order. (auth)

49484 SEMI-MICROSCOPIC THEORY OF HEAVY ION SCATTERING. Greiner, W.; Scheid, W. (Univ., Frankfurt am Main). J. Phys. (Paris), Colloq.; No. 6, 91-112(1971).

From Symposium on heavy ion reactions and many particle excitations; Saclay, France (8 Sep 1971). See CONF-710961.

The interaction between complex nuclei can be calculated by unifying the extended liquid drop model (ELDM) and the two center shell model (ICSM). The sudden and adiabatic approximations are discussed. The imaginary potential is calculated via the transition probability of the molecular states into the compound states. The dependence of the masses in fission and heavy ion scattering on the distance between the fragments seems to be very important. The ^{16}O$-{}^{16}$O and ^{12}C$-{}^{12}$C elastic and inelastic excitation functions are calculated and compared with experiments. The gross structure is interpreted as being due to virtual molecular states while a great part of the fine structure seems to be related to the excitation of quasibound nuclear molecules. (France)

49485 MULTI-NUCLEON TRANSFER REACTIONS. Rotter, I. (Zentralinstitut fuer Kernforschung, Rossendorf, Ger.). J. Phys. (Paris), Colloq.; No. 6, 113-17(1971).

From Symposium on heavy ion reactions and many particle excitations; Saclay, France (8 Sep 1971). See CONF-710961.

The main properties of multi-nucleon transfer reactions induced by heavy ions are discussed. If the ion has a simple structure, unambiguous spectroscopic information on the many-particle structure of nuclear states can be obtained. (France)

49486 USE OF REGGE-POLE ANALYSES TO EXTRACT POSSIBLE QUASI MOLECULAR ROTATIONAL BANDS FROM ELASTIC HEAVY ION CROSS SECTIONS. Mc Voy, K. W. (Indiana Univ., Bloomington). J. Phys. (Paris), Colloq.; No. 6, 119-24(1971).

From Symposium on heavy ion reactions and many particle excitations; Saclay, France (8 Sep 1971). See CONF-710961.

If a rotational band extends above a breakup threshold, its members will be resonances rather than bound states. If in addition they are sufficiently broad, the overlap, their relative phases and amplitudes will determine the way in which they interfere with one another in scattering and reaction cross sections. It is pointed out that a Regge pole provides a convenient and economical parametrization of these amplitudes. (France)

49487 STATISTICAL ASPECTS OF HEAVY-ION REACTIONS. Bondorf, J. P.; Dickmann, P.; Gross, D. H. E.; Siemens, P. J. (Niels Bohr Institutet, Copenhagen). J. Phys. (Paris), Colloq.; No. 6, 145-9(1971).

From Symposium on heavy ion reactions and many particle excitations; Saclay, France (8 Sep 1971). See CONF-710961.

Nucleon transfer reactions between heavy ions above the Coulomb barrier exhibit features that can neither be understood in terms of one step processes nor by assuming the formation of a compound nucleus. Therefore the intermediate concept of a partial statistical equilibrium is introduced. The available experimental data are consistent with the theory for neutron transfer processes. Proton stripping reactions are enhanced less strongly than predicted theoretically. This can be understood as an effect of the Coulomb barrier between the ions. (France)

49488 TWO-NUCLEON TRANSFER REACTIONS AMONG HEAVY IONS. Broglia, R. A. (Niels Bohr Institutet, Copenhagen); Kammuri, T.; Liotta, R.; Winther, A.; Nilsson, B. J. Phys. (Paris), Colloq.; No. 6, 151-3(1971).

From Symposium on heavy ion reactions and many particle excitations; Saclay, France (8 Sep 1971). See CONF-710961.

The DWBA theory of two-nucleon transfer reactions between heavy ions is presented. Finite-range effects are taken into account by means of the Buttle–Goldfarb approximation. The ^{A}Zr(^{16}O,^{18}O)$^{A-2}$Zr reactions are discussed. (France)

49489 COULOMB EXCITATION OF DEFORMED NUCLEI IN A MICROSCOPIC MODEL. Dietrich, K.; Hara, K. (Univ., Heidelberg. Kernforschungszentrum, Karlsruhe, Ger.). J. Phys. (Paris), Colloq.; No. 6, 179-81(1971).

From Symposium on heavy ion reactions and many particle excitations; Saclay, France (8 Sep 1971). See CONF-710961.

A simple microscopic theory of Coulomb excitation of deformed nuclei is proposed. The mechanism of the enhanced transfer of the angular momentum quanta is interpreted in terms of the intrinsic symmetry violation, so that the analogy to the enhanced transfer of nuclear Cooper-pairs between superconducting nuclei becomes particularly transparent. (France)

49490 THEORY OF A NUCLEAR JOSEPHSON EFFECT IN REACTIONS BETWEEN HEAVY IONS. Dietrich, K.; Hara, K.; Weller, P. (Univ., Heidelberg. Kernforschungszentrum, Karlsruhe, Ger.). J. Phys. (Paris), Colloq.; No. 6, 183-4(1971).

From Symposium on heavy ion reactions and many particle excitations; Saclay, France (8 Sep 1971). See CONF-710961.

In the semi-classical treatment of reactions involving multiple pair transfer, each nucleus is represented by a system of two degenerate levels. The model displays enhanced transfer of pairs into the ground states and pairing vibrational states of the interacting nuclei. (France)

49491 ALPHA-PARTICLE RESONANT STATES IN MEDIUM WEIGHT NUCLEI. Dudek, A.; Hodgson, P. E. (Oxford Univ.). J. Phys. (Paris), Colloq.; No. 6, 185-7(1971).

From Symposium on heavy ion reactions and many particle excitations; Saclay, France (8 Sep 1971). See CONF-710961.

It is suggested that the quartet states found in (^{16}O,^{12}C) alpha-transfer reactions may also be interpreted as alpha-particle resonant states. The Saxon–Woods potential was used to calculate the energies of these states and the overall features of the observed resonances were obtained. (France)

49492 NEW APPROACH TO THE CALCULATION OF DEFORMED NUCLEI. Grin, Yu. T. (Inst. of Atomic Energy, Moscow). J. Phys. (Paris), Colloq.; No. 6, 201(1971).

From Symposium on heavy ion reactions and many particle excitations; Saclay, France (8 Sep 1971). See CONF-710961.

The application of the K-harmonic method for the calculation of deformed nuclei is given. (France)

49493 EFFECTS OF ANTISYMMETRIZATION ON POTENTIALS IN HEAVY ION SCATTERING. Park, J. Y. (North Carolina State Univ., Raleigh); Scheid, W.; Greiner, W. J. Phys. (Paris), Colloq.; No. 6, 245-7(1971).

From Symposium on heavy ion reactions and many particle excitations; Saclay, France (8 Sep 1971). See CONF-710961.

Antisymmetrization effects in heavy-ion scattering are studied by expanding the total wavefunction according to the number of exchanged nucleons. A formula for the additional contribution to the effective potential due to antisymmetrization effects is obtained. (France)

49494 ADIABATIC POTENTIALS FOR HEAVY ION COLLISIONS. Rayet, M.; Reidemeister, G. (Univ., Brussels). J. Phys. (Paris), Colloq.; No. 6, 259-60(1971).

From Symposium on heavy ion reactions and many particle excitations; Saclay, France (8 Sep 1971). See CONF-710961.

Adiabatic potentials in heavy ion collisions are calculated by minimizing the expectation value of the nuclear Hamiltonian containing an effective two-body force. Results are given for $\alpha-\alpha$ scattering in an atomic approximation and ^{16}O$-{}^{16}$O scattering in the molecular two center model. (France)

49495 ALPHA-CORRELATIONS IN NUCLEI. Ripka, G. (CEN de Saclay, Gif-sur-Yvette, France). J. Phys. (Paris), Colloq.; No. 6, 261-4(1971).

From Symposium on heavy ion reactions and many particle excitations; Saclay, France (8 Sep 1971). See CONF-710961.

It is suggested that the states which are selectively excited in

α-transfer reactions have strong α-correlations which are defined as a spatial correlation between nucleons. It is shown how present nuclear models can account for these correlations and how saturation properties and the energies of single particle orbits can determine the amount of p-state repulsion responsible for α-clustering. (France)

49496 POSSIBLE MODEL FOR MULTINUCLEON TRANSFER. Toepffer, C. (Univ., Frankfurt am Main). J. Phys. (Paris), Colloq.; No. 6, 291-3(1971).

From Symposium on heavy ion reactions and many particle excitations; Saclay, France (8 Sep 1971). See CONF-710961.

The relation between the scattering angle and the energy loss in multinucleon transfer reactions was established from the study of the quasiclassical transition matrix elements. For the collision process leading to multinucleon transfer, a mechanism is proposed, in which elementary collisions take place between the nucleons in the overlap region of the nuclei. (France)

49497 CONCLUDING REMARKS. Bloch, C. (CEN de Saclay, Gif-sur-Yevette, France). J. Phys. (Paris), Colloq.; No. 6, 299-303(1971).

From Symposium on heavy ion reactions and many particle excitations; Saclay, France (8 Sep 1971). See CONF-710961.

Some of the most striking experimental data presented at the conference and their interpretation in terms of quartets are reviewed. (France)

49498 ROLE OF SIMPLE CONFIGURATIONS IN UNDERSTANDING NUCLEAR STRUCTURE AND REACTIONS. Cindro, N. (Rudjer Boskovic Inst., Zagreb. Univ., Zagreb). Riv. Nuovo Cim.; 2: No. 2, 170-88(1972).

Underlying the complicated structure of energy spectra and cross sections there are always simple configurations responsible for the basic structure of these physical quantities. As these configurations comprise only a few degrees of freedom, they will appear preferentially in direct or semidirect reactions. The important point in studying the underlying simplicity of seemingly complex configurations is to consider the variation of the cross section as a function of the energy of the outgoing particle, not of the incident particle. The theoretical formulation is based on the hierarchical classification of nuclear levels: all levels are equal, but some are more equal than others. The principal, most important level in this hierarchical order would be the simple configuration that channels the process. The results are compared with experiment, and the agreement is reasonable. (11 figures, 1 table) (R.W.R.)

49499 EFFECT OF EXCHANGE CURRENTS ON ORBITAL g-FACTORS AND E1 SUM RULE FOR PHOTOABSORPTION. Fujita, Jun-ichi (Tokyo Univ. of Education); Yamaji, Shuhei; Hirata, Michihiro. J. Phys. Soc. Jap.; 33: No. 2, 541-50(Aug 1972).

The simple relation between the change of orbital g factors due to exchange currents and the sum rule for E1 photoabsorption, which has recently been proposed on the basis of the Fermi gas model, is reexamined from the viewpoint of the shell model for several examples. In the course of the study, the foundation of the conventional theories on nuclear moments is discussed from a more general viewpoint. (1 figure, 1 table) (auth)

49500 CLASSICAL MODEL OF COLLECTIVE MOTIONS IN THE O. BOHR–MOTTELSON THEORY. Nevzglyadov, V. G. (Far-Eastern State Univ., Vladivostok, USSR). Dokl. Akad. Nauk SSSR; 202: No. 6, 1292-5(21 Feb 1972). (In Russian).

Starting with the Lagrange equation, the classical inertial motion of a nucleus corresponding to the O. Bohr–Mottelson (Nilsson–Mottelson) model is sought, i.e., motion described by the Lagrange function $L = T - U$. The approach is thus quite different from the model of a charged drop of an ideal, incompressible liquid, where motion involves rotation of a shell. The resulting development makes no allowance for rotational bands; in order to obtain a rotational band it is necessary to generalize the theory for the case of a rotational motion of the nuclear substance. (K.S.W.)

49501 ROLE OF HEAT EFFECTS IN A REACTION OF COMPLETE FUSION OF NUCLEI. Kalinkin, B. N.; Petkov, I. Zh. (Inst of Physics, Sofia). Compt. Rend. Acad. Bulg. Sci.; 25: No. 1, 23-6(1972). (In Russian).

A model for the fusion reaction of two complex nuclei had previously been proposed by the same authors and utilized to calculate the cross section for compound-nucleus formation: a rotating, deformed nucleus with charge $Z = Z_1 + Z_2$, and mass number $A = A_1 + A_2$, and possessing an angular momentum l. In a model which does not consider the heat portion of the energy of reaction the nucleus may be described as "cold." In further examination of a compound nucleus having an excitation energy of the order of 100 MeV, some "macroscopic" characteristics of the thermodynamics of this nucleus are explored. (K.S.W.)

49502 CONSISTENT RPA FORMALISM. Johns, Oliver (Technische Univ., Garching, Ger.). Z. Phys.; 253: No. 4, 269-81(1972).

The quasi-boson and generator-coordinate derivations of the RPA are examined and is concluded that they make uncritical and inconsistent use of the assumption that ground state correlations be small. It is proposed that consistent derivations of the RPA to various orders can be carried out by explicit retention of a certain power of a parameter γ which is proportional to the norm of the ground state correlations. To illustrate such a method, it is proved that a consistent, nontrivial, linear RPA theory exists only if the residual potential is small enough for first order perturbation theory to be valid. (auth)

PHYSICS (PLASMA AND THERMONUCLEAR)

Confinement and Heating

Refer also to abstract 49557.

49503 (COO–2181-7) SIMULATION AND ANALYSIS OF PARTICLE MOTION IN MAGNETIC MIRRORS WITH HIGH FREQUENCY FLUCTUATIONS. Aamodt, R. E. (Colorado Univ., Boulder. Dept. of Astro-Geophysics); Byers, J. A. (California Univ., Livermore. Lawrence Livermore Lab.). Jul 1972. Contract AT(11-1)-2081. 17p. Dep. NTIS.

Particle motion in a magnetic mirror containing high-frequency short-wavelength longitudinal electric fields is followed numerically for many mirror bounce periods. It is found that while the magnetic moment undergoes large rapid changes, these fluctuations seldom imply particle loss from the mirror. This behavior is shown to be completely consistent with nonlinear superadiabatic theory, wherein containment properties of the trap are affected only when particles cross isolated singular surfaces in phase space. (auth)

49504 (COO–2181-9) NONLINEAR PHENOMENA IN COLLISIONLESS PLASMAS. Progress Report, September 1, 1971–August 31, 1972. Aamodt, Richard E.; Hoffman, J. (Colorado Univ., Boulder). [nd]. Contract AT(11-1)-2081. 5p. Dep. NTIS.

The phenomena of neoclassical particle loss rates from mirror machines, and the coupling of radiation into or out of dense plasmas were studied. A brief discussion of this research is presented. (M.O.W.)

49505 (IPPJ–110) EXPERIMENTS OF PLASMA CONFINEMENT IN JIPP STELLARATOR. II. CONVECTIVE MOTIONS DUE TO TRAPPED PARTICLES IN STELLARATOR FIELD. Miyamoto, Kenro; Mohri, Akihiro; Inoue, Nobuyuki; Fujiwara, Masami; Yatsu, Kiyoshi (Nagoya Univ. (Japan). Inst. of Plasma Physics). Oct 1971. 19p. NTIS (U. S. Sales Only).

Dependences of plasma confinement on the properties of the stellarator field such as the rotational transform angle, shear, well depth, the magnitude B as well as the plasma parameters over a relatively wide range were studied using several kinds of plasma sources. The observed diffusion coefficients are $1/20 \sim 1/30$ times the Bohm coefficient. Convective motions of $E \times B$ drift due to the trapped particles at the corners of the magnetic surface of the $l = 3$ stellarator were observed by measuring the distributions of the densities and potentials over the plasma cross section. The magnitude of the observed decay time τ and the scaling law of B and T_e dependences of τ can be explained by an order-of-magnitude discussion by the observed convective motions and the low-frequency fluctuations observed in the boundary region. (auth)

49506 (IPPJ–111) ION CYCLOTRON RESONANCE PLUGGING AND HEATING OF CUSPED PLASMA. Miyake, Shoji (Nagoya Univ. (Japan). Inst. of Plasma Physics). Oct 1971. 25p. NTIS (U. S. Sales Only).

Ion cyclotron resonance plugging and heating of cusped plasma were experimentally investigated. A helium plasma was steadily fed from one of the point cusps into the containment region. The density was varied from 10^8 to 10^{11} cm^{-3}. With a plugging rf electric field of 100 V/cm, it was found that 97% of the line-cusp loss was blocked at the ion cyclotron resonance condition and that the mean energy of the contained ions was 40 eV. For the line-cusp loss, good plugging was observed up to 10^{11} cm^{-3}, but for the point-cusp loss it was limited below 10^{10} cm^{-3}. Heating of ions by an electrostatic ion cyclotron wave is calculated, taking into account the role of the nonuniformity of the magnetic field. The results are compared with experimental ones. (auth)

49507 (LA–4984) MODEL FOR THE INSTABILITY ABSORPTION IN A LASER HEATED PLASMA. Mjolsness, R. C.; Ruppel, H. M. (Los Alamos Scientific Lab., N. Mex.). Jun 1972. Contract W-7405-eng-36. 7p. Dep. NTIS.

A model is presented for the evaluation of the laser flux absorbed by a plasma-instability mechanism. The model is suitable for inclusion in hydrodynamic codes. The absorbed flux is proportional to a two-parameter function, which is given in phenomenological form. While the theory has been made consistent with existing theoretical information on the behavior of instability absorption, a considerable extrapolation of existing theory is necessary to evaluate the absorbed flux uniquely. (auth)

49508 (LA–4986) OCCURRENCE OF HIGH-ENERGY ELECTRONS AND SURFACE EXPANSION IN RADIANTLY HEATED TARGET PLASMAS. Morse, R. L.; Nielson, C. W. (Los Alamos Scientific Lab., N. Mex.). Jul 1972. Contract W-7405-eng-36. 15p. Dep. NTIS.

It is shown that limitations on collisionless electron thermal conduction place a lower limit on the range of energies of electrons in the surface of target plasmas which are heated by incident electromagnetic radiation, and that in cases of contemporary experimental interest these energies can be hundreds of keV. It is then shown that these high energy electrons can cause a much faster expansion of plasma from the heated surface than would be predicted by a single fluid theory. Numerical simulations demonstrate both effects. (auth)

49509 (NP–19379) HIGH-FREQUENCY PLASMA HEATING. Golant, V. E.; Piliya, A. D. (Akademiya Nauk SSSR, Leningrad. Fiziko-Tekhnicheskii Institut). 1972. 52p. (In Russian). Dep. NTIS (U. S. Sales Only).

Perspectives of high-frequency plasma heating in quasi-stationary thermonuclear installations are discussed. Linear conversion of incident electromagnetic waves into heavily damped slow plasma waves is considered as a method of heating. In this respect, a brief review of both theoretical and experimental results on linear wave conversion is given. On the basis of available data, the possibilities of successful high-frequency heating in large-scale toroidal traps are estimated and problems are discussed. Results of recent experiments on high-frequency plasma heating in "tokamak"-type installations are presented. (auth)

49510 (NP–19401) FAST RADIAL MOTION OF TOROIDAL PLASMA COLUMN IN TRANSVERSE MAGNETIC FIELD. Kaganskii, M. G.; Ovsyannikov, V. A.; Tyul'panov, S. S. (Akademiya Nauk SSSR, Leningrad. Fiziko-Tekhnicheskii Institut). 1972. 11p. (In Russian). Dep. NTIS (U. S. Sales Only).

Results of the experiments on "Tuman-2" device are described. A transverse magnetic field with amplitude up to 60 G and 50-μsec rise time was applied to an equilibrium plasma column inside a conductive shell. The plasma current was 5 kA. The measurements showed that column radial velocity was determined by velocity of the transverse field increase at small displacements. Sharp plasma column hindering was observed with a displacement increase. The effect was caused by cross current creation, which closes over the diaphragm. (auth)

49511 (ORNL–4793, pp 10-17) MIRROR CONFINEMENT. Ard, W. B.; Becker, M. C.; Blue, C. W.; (and others) (Oak Ridge National Lab., Tenn.). Aug 1972.

In Thermonuclear Division annual progress report, 1971.

Experiments have begun in the superconducting mirror-quadrupole facility, IMP. Target plasmas are produced by electron-cyclotron heating, using up to 600 W at 36 GHz (resonant at B = 12.5 kG) with supplemental nonresonant power (up to 1 kW at 55 GHz). Measurements of the maximum target density indicate $n_e \approx 3 \times 10^{12}$ cm^{-3} (with an uncertainty of a factor of 2), an order of magnitude higher than those found in INTEREM, therefore implying a scaling like B^2. Measurements of the axial density profile of the hot-electron plasma were made in INTEREM based on bremsstrahlung intensity, using an array of collimated NaI(Tl) detectors. The components of perpendicular and parallel pressure produced by the plasma can also be obtained from these measurements. The observed peaking of high-energy particles close to the midplane can be caused by two processes: (1) nonresonant heating of high-energy particles and (2) influence of the plasma pressure to distort the vacuum magnetic field which results in the observed equilibrium. At high beta, one cannot yet distinguish between these possibilities. The stabilizing influence of nonresonant heating on the observed microinstabilities in INTEREM is interpreted as due to the increased population of relativistic electrons in the distribution function. The postulate that such heating reduces the anisotropy and therefore improves stability is refuted by axial density measurements. (auth)

49512 (ORNL–4793, pp 33-45) TURBULENT HEATING. Alexeff, Igor; Berry, L. A.; Estabrook, K. G.; Hirose, A.; Neidigh, R. V.; Wing, W. R. (Oak Ridge National Lab., Tenn.). Aug 1972.

In Thermonuclear Division annual progress report, 1971.

This is a final report of the ORNL study of, and experiment with, the turbulent heating of plasmas. It contains the latest revisions to the turbulent heating theory and corroborating experimental data. There is now ample evidence that the maximum average velocity to which plasma ions may be heated is controlled by the energy density of the turbulence, and not the lower drift velocity difference between ions and electrons. Final experiments on Burnout VI, scaling laws, the extrapolation to a "next-generation" experiment, and some basic plasma physics are included. (auth)

49513 (ORO–3458-34) PLASMA CONFINEMENT AND TURBULENCE THEORY. Drummond, W. E. (Texas Univ., Austin.

Center for Plasma Physics and Thermonuclear Research). [nd]. 11p. Dep. NTIS.

Brief discussions of research are given for the following areas: (1) neoclassical transport, (2) dynamic behavior of tokamaks, (3) axisymmetric divertor, (4) microinstabilities in tokamaks, and (5) turbulent heating. (M.O.W.)

49514 (ORO-4087-8) TEXAS TURBULENT TORUS EXPERIMENT. Progress Report. (Texas Univ., Austin. Center for Plasma Physics and Thermonuclear Research). 1 Jul 1972. Contract AT(40-1)-4087. 97p. Dep. NTIS.

The general objectives of the experiment are discussed together with the planned experimental program. Detailed descriptions are given of the experimental apparatus along with diagnostic equipment. (M.O.W.)

49515 (TID-26086) REPORT OF VISIT TO USSR BY U. S. ENERGETIC BEAM TEAM, APRIL 1-15, 1972. (Energetic Beam Team (U. S.)). 1972. 33p. Dep. NTIS.

Plasma physics institutes in the USSR were visited. Research programs currently being conducted are mentioned. However, topics of prime interest are those facilities dealing with beam injection. The report describes the trip and some of its highlights. (M.O.W.)

49516 (UCRL-51247) CHARGE EXCHANGE PROCESSES IN 2XII. Hiskes, John R. (California Univ., Livermore. Lawrence Livermore Lab.). 22 Jun 1972. Contract W-7405-eng-48. 23p. Dep. NTIS.

The processes leading to charge exchange loss of the 2XII plasma are discussed, with the background gas presumed to be either deuterium or methane molecules. The mean free path for these molecules impinging on the plasma is found to be a small fraction of the plasma radius. The background gas density during plasma confinement, as determined by a fast atom detector in the median plane, is two to three orders of magnitude higher than the initial background gas density. Electric fields in the plasma may sweep the molecular reaction products out of the median plane, causing the charge exchange losses from these products to go undetected. These additional losses outside the median plane are estimated to be two to five times larger than observed by the fast atom detector located in the median plane. When these additional losses are taken into account, the total charge-exchange loss rate from the plasma is still at least a factor of ten less than is required to explain the observed plasma decay. (auth)

49517 PLASMA HEATING BY LARGE-AMPLITUDE, LOW-FREQUENCY ELECTRIC FIELDS. Kruer, W. L. (Princeton Univ., N. J.); Katz, J.; Byers, J.; DeGroot, J. Phys. Fluids; 15: No. 9, 1613-16(Sep 1972).

Computer simulations of plasmas driven by large-amplitude electric fields oscillating near the ion plasma frequency are presented. The large field excites an instability which leads to an efficient heating of the plasma. This is an instantaneous electron–ion two-stream instability due to the slowly oscillating drift between electrons and ions. A simple theory gives the instability properties and the observed plasma heating. (auth)

49518 RESONANCES IN THE COLLISIONLESS HEATING OF A PLASMA BY TRANSIT TIME MAGNETIC PUMPING. Lashmore-Davis, C. N.; May, R. M. (United Kingdom Atomic Energy Authority, Abingdon, Eng.). Phys. Fluids; 15: No. 9, 1616-19(Sep 1972).

Using a general expression for the power absorbed by transit time magnetic pumping, the resonances in the heating, due to the three low-frequency electromagnetic waves which can propagate in a plasma in a magnetic field, are calculated. The strengths and widths of the three resonances are compared under conditions where the electrons absorb most of the power. The ion-acoustic resonance is the broadest and the magneto acoustic (or compressional Alfvén) the strongest. The Alfvén (or shear Alfvén) wave is undamped when cyclotron damping and terms of order ω^2/ω_{ci}^2 are neglected. However, when terms of order ω^2/ω_{ci}^2 are included, the Alfvén wave is shown to have a stronger resonance than the ion-acoustic wave. Numerical results were also obtained for the magneto-acoustic resonance under conditions where the ions are also heated, and the width of the resonance is much broader than for pure electron heating. (auth)

49519 DEUTERIUM-TRITIUM HEATING TO THERMONUCLEAR TEMPERATURES BY MEANS OF ION-ION COLLISIONS IN THE PRESENCE OF INTENSE LASER RADIATION. Mjolsness, R. C.; Ruppel, H. M. (Los Alamos Scientific Lab., N. Mex.). Phys. Fluids; 15: No. 9, 1620-9(Sep 1972).

The laser heating of deuterium and tritium ions by small angle D–T collisions is calculated, assuming that ion distribution functions are displaced Maxwellians with average velocity determined by the laser electric field. For all conditions of high radiation intensity the ion temperature will increase as $t^{2/5}$ to good approximation. The heating times are of the order of $t \sim 10^{-9}(E_0/10^{10}\ \text{esu})^{-2}(n/10^{21}\ \text{cm}^{-3})^{-1}(\lambda/10^{-4}\ \text{cm})^{-2} \times (T/10^8\ \text{K})^{5/2}$ sec. At high laser fluxes this mechanism dominates electron–ion heat transfer by several orders of magnitude and results in substantial heating of ions in adjacent nonlaser-irradiated plasma, through ion–ion heat conduction. The heating rate is examined for a plasma of two arbitrary ion species. The heating rate is sensitive to ion masses and charges, and it appears that the above heating time can be shortened by as many as three to five orders of magnitude. A D–T plasma may be brought to thermonuclear temperatures by this mechanism, but this requires laser fluxes and laser energies two to three orders of magnitude larger than currently available. (auth)

49520 BEAT HEATING OF A PLASMA. Cohen, Bruce I.; Kaufman, Allan N.; Watson, Kenneth M. (Univ. of California, Berkeley). Phys. Rev. Lett.; 29: No. 9, 581-4(28 Aug 1972).

If two laser beams have a difference frequency nearly equal to the plasma frequency, nonlinear interaction resonantly excites longitudinal plasma oscillations. These then induce transitions to other transverse modes. Nonlinear damping of the longitudinal mode heats the plasma. The process is optimized by having parallel beams, equal laser intensities, and damping equal to the frequency mismatch. (auth)

49521 AVERAGED EQUATIONS OF THE COMBINED PROCESSES OF HYDRODYNAMIC EXPANSION AND CONDUCTION HEATING OF PLASMA, THE RECOVERED ENERGY OF NUCLEAR FUSION BEING TAKEN INTO CONSIDERATION. I. THE PLANE PROBLEM. Kaliski, S. (Inst. of Fundamental Technical Problems, Warsaw). Bull. Acad. Pol. Sci., Ser. Sci. Tech.; 20: No. 4, 297-304(1972).

Joint equations are established to describe hydrodynamic expansion and thermal conductivity heating of plasma, taking into consideration the recovered energy of thermonuclear fusion in an averaged description. This improves in an essential manner the existing methods for averaged description of laser heating of plasma. The plane problem is considered. The spherical (cylindrical) problem is treated separately because of the different principle of constructing the equation replacing the second equation of momentums. (auth)

49522 ALTERNATIVE DESCRIPTION OF THE CONDUCTION-TYPE LASER HEATING PROCESS OF TWO-TEMPERATURE PLASMA IN THE SPHERICALLY SYMMETRIC CASE, THE NUCLEAR FUSION ENERGY BEING TAKEN INTO CONSIDERATION. Kaliski, S. (Inst. of Fundamental Technical Problems, Warsaw). Bull. Acad. Pol. Sci., Ser. Sci. Tech.; 20: No. 4, 305-12(1972).

The equations of conduction-type laser heating of two-temperature plasma are derived and solved in a manner different from earlier calculations (the two methods thus forming an alternative) in the case of spherical (cylindrical) symmetry, taking into consideration the thermonuclear fusion energy and using an averaged description. Similarly to the case of one-temperature plasma the present approach leads, in the plane problem, to the same equations as were obtained by the method of momentums, without the necessity of introducing additional physical relations. If the recovered energy is neglected and the one-temperature approximation is used, the two methods lead to results which are qualitatively identical. The present method for averaging the equations enables, in the spherically symmetric case, an additional approximation to the real process to be obtained. (auth)

49523 HEATING OF IONS BY MODULATED MICROWAVES. Honzawa, T.; Aihara, S.; Hosokawa, M.; Ikegami, H. (Nagoya Univ., Japan). Phys. Lett.; 40A: No. 4, 335-6(31 Jul 1972).

Ion heating is studied by modulating a microwave power at low frequencies in a hot electron plasma generated by microwave discharges in a mirror machine. The modulation is observed to be effective for heating ions. (auth)

Diagnostics

49524 (AD-737518) PLASMA INVERSE SCATTERING THEORY. Balanis, George N. (California Inst. of Tech., Pasadena. Antenna Lab.). Dec 1971. 137p. (AFOSR-TR-72-184). NTIS.

The electron density profile of plane stratified inhomogeneous plasmas is calculated using a numerical solution of the inverse scattering algorithm. The inverse scattering algorithm connects the time dependent reflected field resulting from a delta-function field incident normally on the plasma to the inhomogeneous plasma density. Examples show that the method produces uniquely the electron density on or behind maxima of the plasma frequency. It is shown that the delta-function incident field used in the inverse scattering algorithm can be replaced by a thin square pulse. (auth) (NTIS)

49525 (AD–737561) ION BEAM PROBE FOR ST TOKAMAK. Scientific Report No. 6 (Final). Hickok, Robert L.; Jobes, Forrest C. (Mobil Research and Development Corp., Princeton, N. J. Central Research Div. Lab.). Feb 1972. Contract F44620-69-C-0049. 126p. (AFOSR-TR–72-18). NTIS.

The design, construction and operation of a heavy ion beam probe for measuring plasma density, space potential, and current density on the ST Tokamak is described. The beam probe utilizes a 200-keV, 20-μA, Tl$^+$ ion beam and provides three-dimensional space resolution of the order of 0.1 cm^3, time resolution of the order of 0.0001 sec, simultaneous measurements of all three plasma parameters, and information that is continuous in both space and time. Preliminary results show good clean signals for all three quantities with signal-to-noise ratio of the order of 100 to 1. The results establish that there are density fluctuations in the ST plasma that are localized to finite radial positions. The preliminary results also indicate that the space potential goes negative towards the center of the plasma. More work remains in order to obtain quantitative interpretations of the current-density signals and to increase the operating range of the beam probe system. (auth) (NTIS)

49526 (AD–737655) MICROWAVE SCATTERING FROM UNDERDENSE AND OVERDENSE TURBULENT PLASMAS. Attwood, David (New York Univ., N. Y. Dept. of Electrical Engineering). 1971. Contract N00014-67-A-0467-0018. 9p. NTIS.

Experimental results of microwave scattering from a turbulent plasma are presented. As electron density is increased beyond the critical value, a transfer from volume to surface scattering is observed. Overdense scattering is characteristic of a cylinder displaying orientation fluctuations. (auth) (NTIS)

49527 (AD–738306) DESIGN, DEVELOPMENT, AND APPLICATION OF A COMPLETE ANALOG PLASMA-DIAGNOSTIC SYSTEM. Nordlund, Daniel R.; Breaux, Onezime P. (Systems Research Labs., Inc., Dayton, Ohio). Sep 1971. Contract F33615-68-C-1398. 25p. (AFAL-TR–71-294). NTIS.

The simple electronic diagnostic system described provides a calibrated oscilloscope display of a Langmuir-probe I–V characteristic, its first- and second-derivative curves, the electron-energy distribution function, and the cumulative electron number density. The system also provides a simple method for determining plasma potential and, if it exists, the electron temperature. Data taken in a low-temperature mercury discharge is compared with data taken by means of the well-known harmonic second-derivative technique. An electron density of 4.9×10^{16} m^{-3} and an electron temperature of 9,700°K found with the new system compare very favorably to values of 4.7×10^{16} m^{-3} and 9,900°K determined from the harmonic second-derivative data. The system described features more rapid data reduction and lower cost than existing harmonic systems. A detailed design procedure for construction of the accurate differentiators is given. (auth) (NTIS)

49528 (AD–738633) OPTICAL INTERFEROMETERS APPLIED TO THE DIAGNOSTICS OF PLASMAS. Final Scientific Report, January 1, 1968–December 31, 1971. Hirschberg, Joseph G. (Miami Univ., Coral Gables, Fla. Dept. of Physics). 28 Feb 1972. 194p. (AFOSR-TR–72-571). NTIS.

The various projects of the Laboratory, principally the multichannel Fabry–Perot, density interferometers, high-atmosphere measurements, laboratory plasma studies, solar eclipse study, multiplex Fabry–Perot interferometer and Fabry–Perot duochromator are described. Publications pertaining to these and other activities of the Laboratory are listed, and a number of them are included in full. (auth) (NTIS)

49529 (EUR-CEA-FC–632) MICROWAVE MEASUREMENTS OF THE LOCAL SHEARING OF A MAGNETIC FIELD IN A PLASMA. Chaignot, G. (Commissariat a l'Energie Atomique, Fontenay-aux-Roses (France). Centre d'Etudes Nucleaires). Feb 1972. 65p. (In French). Dep. NTIS (U. S. Sales Only).

Thesis. Submitted to Paris Univ., Orsay (France).

A microwave diagnostics method, enabling the direction of a magnetic field in a confined plasma to be determined, is presented. The principle of this method resides in the existence of highly localized nonlinear phenomena in the plasma when an electromagnetic wave is propagated through it with the extraordinary mode perpendicular to the inhomogeneous magnetic field. An analysis of the polarization of the harmonic generated in the plasma allows the direction of the magnetic field at the point of interaction to be obtained. Varying the incident frequency or the principal magnetic field enables a spatial scanning of the plasma to be effected which allows the displacement in the plasma of the position of the measurement point, the shearing profile of the magnetic field being thus obtained. A series of experiments carried out under conditions simulating those of the plasma of the Tokamak machine are described. In particular, a measurement of the local shearing of a magnetic field was effected with a satisfactory accuracy and a very high spatial resolution. (France)

49530 (INR–1388) CONTOURS OF THE SPECTRAL LINES OF INHOMOGENEOUS PLASMA FOR APPARENT INCREASE OF OPTICAL THICKNESS (MEASUREMENTS OF PLASMA TEMPERATURE). Litski, Yanush; Sukever, Shymon (Institute of Nuclear Research, Warsaw (Poland)). 1972. 23p. (In Russian). Dep. NTIS (U. S. Sales Only).

Calculations of two spectral line contours (Na I 5688 Å and Na I 5890 Å) for a plasma with an inhomogeneous temperature, located between two parallel mirrors, are presented. The calculations were performed for a few values of the apparent increase of plasma optical thickness and two temperature distribution functions in the boundary layers. It was shown, that for "1/7" temperature distribution law, the accuracy of the temperature measurements by the method of registration of absolute intensity is practically the same as that by the spectral-line-reversal method for both lines. For a laminar-like plasma stream, better accuracy was obtained by using the line 5688 Å than in the case of the resonance lines. (auth)

49531 (JAERI-M–4596) SPECTROSCOPIC MEASUREMENTS IN THE TOKAMAK-TYPE FACILITIES. Kasai, Satoshi; Funahashi, Akimasa; Itoh, Satoshi (Japan Atomic Energy Research Inst., Tokyo). Sep 1971. 48p. (In Japanese). NTIS (U. S. Sales Only).

Spectroscopic measurements that have been performed in Tokamaks are reviewed. The descriptions are grouped into measurements of ion and electron temperatures, particle confinement-time, neutral-atom density, impurity, and MHD equilibrium and instabilities. In addition, previous results determined by spectroscopic methods are arranged in tabular form. (auth)

49532 (ONERA-TN–174) PLASMA ACCELERATION BY A TRAVELLING ELECTROMAGNETIC FIELD. GENERAL DIAGNOSTICS AND VELOCITY MEASUREMENT. Charpenel, Marc; Rager, Jean-Pierre; Sitt, Bernard (Office National d'Etudes et de Recherches Aerospatiales, Chatillon-sous-Bagneux (France)). 1971. 29p. (In French). Dep. NTIS (U. S. Sales Only).

An experimental set-up was designed in view of studying the processes of ionization and acceleration of a plasma in a traveling electromagnetic field, and of exploring its fundamental characteristics (temperature, density, velocity). This apparatus works in a pulsed region so that simple diagnostic methods can be used for measuring the electric and magnetic fields, the induced current density, the temperature, and the velocity. An indirect technique is also used for determining the last two parameters. The overall results are analyzed and discussed. They apparently show that there exists, near the exhaust section, a temperature wave traveling at the same velocity as that of the relative electric field. (France)

49533 (ORNL–4793, pp 46-8) ATOMIC PHYSICS AND PLASMA DIAGNOSTICS. Barnett, C. F.; Berisch, R.; Ray, J. A. (Oak Ridge National Lab., Tenn.). Aug 1972.

In Thermonuclear Division annual progress report, 1971.

Studies are being made to determine the feasibility of replacing the gas stripping cell in the neutral-particle spectrometer with 100- to 300-Å carbon and aluminum foils. Transmission through the foils of 250-eV protons has been achieved with an energy loss of 170 eV. All thin foils tested have microscopic cracks which prevent accurate calibration of the transmission coefficient. Experimental work concerning the physics of excited states of hydrogen molecules has been suspended and awaits the further theoretical development that the effect of level crossing between the 1-σg ground electronic state and the 1-σu excited state has on the electron capture process and the high Rydberg-state populations. Plasma diagnostics development during the past year includes: (1) detection of total energy escaping a plasma, using pyroelectric crystals, (2) neutron spectrometers, (3) feasibility studies of heavy-ion beam and CO$_2$ laser-beam probing of plasmas. (auth)

49534 SPATIAL MEASUREMENT OF THE MAGNETIC FIELD DIRECTION IN PLASMA. Cano, R.; Chaignot, G.; Fidone, I.; Schwartz, M. J. (CEN, Fontenay-aux-Roses, France). Phys. Fluids; 15: No. 9, 1635-40(Sep 1972).

Experimental results of the determination of the local value of $\theta(x) = B_y(x)/B_z(x)$ in an externally imposed sheared magnetic field are presented. Two microwave methods are used. The first method employs an incident ordinary wave. Measurement of the polarization of the extraordinary wave generated by shear coupling yields the local direction of B. In the second method a large amplitude incident extraordinary wave is used. Measurements of the polarization of locally generated harmonics yield the direction of B at the point of generation. Typically, one has $\theta \simeq 4 \times 10^{-2}$ rad. The precision obtained with both methods is 10^{-2} rad. (auth)

49535 HOT-PROBE MEASUREMENTS OF SPACE POTENTIAL OSCILLATIONS IN A PLASMA. Motley, R. W. (Princeton Univ., N. J.). J. Appl. Phys.; 43: No. 9, 3711-16(Sep 1972).

The amplitude and phase of space potential oscillations are readily measured with a hot electron-emitting probe. Measurements performed in a collisional cesium plasma, unstable to drift waves, are presented and compared with linear drift-wave theory. (auth)

49536 CALIBRATION PROCEDURE TO CORRECT FOR THE EFFECTS OF DIELECTRIC CONTAINERS IN MICROWAVE PLASMA DENSITY MEASUREMENTS. Wellenstein, H. F.; Frommhold, Lothar; Robertson, W. W. (Univ. of Texas, Austin). J. Appl. Phys.; 43: No. 9, 3716-19(Sep 1972).

It is shown that dielectric containers interfere with plasma density determinations and render them too low by large percentages. A way to avoid such errors is described and its usefulness demonstrated. (auth)

49537 INTERFEROMETRIC STUDY OF A TEA–CO_2 LASER PRODUCED PLASMA. Tonon, G.; Rabeau, M. (Centre d'Etudes de Limeil, Villeneuve-Saint-Georges, France). Phys. Lett.; 40A: No. 3, 215-16(17 Jul 1972).

The interferometric study of a TEA-CO_2 laser-produced plasma allowed one to measure the number of electrons produced and to determine their density profile in the absorption region of the laser radiation. (auth)

49538 SIMPLE X-RAY BANDPASS FILTERS FOR NANOSECOND RESOLUTION OF PLASMA SPECTRA. Bernstein, Melvin J. (Aerospace Corp., El Segundo, Calif.). Rev. Sci. Instrum.; 43: No. 9, 1323-7(Sep 1972).

A novel type of bandpass filter for x rays was developed for use in studies of hot transient plasmas. Suitable bandpass intervals are defined by transmission through thin K-edge filters and absorption in matched thicknesses of scintillator material. The scintillator light signals are detected by either a set of photomultipliers or an image-converter camera, operated in the streak mode. Filters of Mg, Al, Cl, and Ti cover the photon energy range 1 to 5 keV and are useful with plasmas having temperatures of 0.2 to 2.0 keV. (auth)

49539 APPARATUS TO INVESTIGATE PLASMAS AT VERY HIGH PRESSURE. Bauder, Uwe H.; Stephens, Everett D. (Air Force Aerospace Research Labs., Wright Patterson Air Force Base, Ohio). Rev. Sci. Instrum.; 43: No. 9, 1341-4(Sep 1972).

Steady-state electrical arc discharges are operated in argon at pressures up to 950 atm and arc currents up to 200 A. The high-pressure system consisting of various arc configurations, pressure vessels, gas and water pumps with heat exchanger and pressure equalization chamber is described. Also, the electrical and spectroscopic measurements performed at the discharges are discussed. Voltage–current dependences of arcs with different currents are presented as functions of the gas pressure and are compared with predictions based on the energy equation of the arc columns. (auth)

Kinetics (General)

Refer also to abstracts 48683 and 49316.

49540 (LIB/Trans–413) STUDY OF X-RAY AND NEUTRON EMISSIONS FROM A NON-CYLINDRICAL DISCHARGE FOCUSING DEVICE. Patou, Claude. Translated by A. Morgan (Australian Atomic Energy Commission), from J. Phys. (Paris); 31: No. 4, 339-50(1970). 21p. Dep. NTIS (U. S. Sales Only).

An abstract of this article prepared from the original appeared as NSA 24: 47276. (Australia)

49541 (N–72–20680) EXPERIMENTAL INVESTIGATIONS OF A URANIUM PLASMA PERTINENT TO A SELF-SUSTAINING PLASMA SOURCE. Schneider, Richard T. (Florida Univ., Gainesville. Dept. of Nuclear Engineering Sciences). Dec 1971. 40p. (NASA-CR-125814). NTIS.

The research is pertinent to the realization of a self-sustained fissioning plasma for applications such as nuclear propulsion, closed cycle MHD power generation using a plasma core reactor, and heat engines such as the nuclear piston engine, as well as the direct conversion of fission energy into optical radiation (nuclear pumped lasers). Diagnostic measurement methods and experimental devices simulating plasma core reactor conditions are discussed. Studies on the following topics are considered: (1) ballistic piston compressor (U-235); (2) high pressure uranium plasma (natural uranium); (3) sliding spark discharge (natural uranium); (4) fission-fragment interaction (He-3 and U-235); and (5) nuclear-pumped lasers (He-3 and U-235). (auth) (STAR)

49542 (N–72–21691) ANALYTICAL AND EXPERIMENTAL INVESTIGATION OF THE COAXIAL PLASMA GUN FOR USE AS A PARTICLE ACCELERATOR. Shriver, Edward L. (National Aeronautics and Space Administration, Huntsville, Ala. George C. Marshall Space Flight Center). Apr 1972. 78p. (NASA-TN-D-6687). NTIS.

The coaxial plasma accelerator for use as a projectile accelerator is discussed. The accelerator is described physically and analytically by solution of circuit equations, and by solving for the magnetic pressures which are formed by the j cross B vector forces on the plasma. It is shown that the plasma density must be increased if the accelerator is to be used as a projectile accelerator. Three different approaches to increasing plasma density are discussed. When a magnetic field containment scheme was used to increase the plasma density, glass beads of 0.66-mm diameter were accelerated to 7 to 8 km per second velocities. Glass beads of smaller diameter were accelerated to more than twice this velocity. (auth) (STAR)

49543 (ORNL–4793) THERMONUCLEAR DIVISION. Annual Progress Report for the Period Ending December 31, 1971. (Oak Ridge National Lab., Tenn.). Aug 1972. Contract W-7405-eng-26. 72p. Dep. NTIS.

A separate abstract was prepared for each of eight sections. (M.O.W.)

For abstracts of individual sections see: 49511, 49512, 49533, 49586 and 49608–49611.

49544 DIATOMIC GAS: THERMAL RADIATION INTERACTION. A MODEL EQUATION FOR THE INTERNAL FLUID. Phillips, Warren F. (Oakland Univ., Rochester, Mich.); Arpaci, Vedat S. J. Plasma Phys.; 7: No. 2, 235-46(Apr 1972).

A model kinetic equation for the internal fluid of diatomic molecules which interacts with thermal radiation is proposed. The cross-collision term developed for the molecule–photon interaction has the property that molecules and the sum of internal and photon energies are conserved. An alternative approach to this term based on the product of two BGKW collision operators yields the same result. It is also shown that the proposed model leads to an H theorem. (auth)

49545 SOME SOLUTIONS REPRESENTING A DIPOLE FIELD IMMERSED IN AN INFINITE PLASMA. Sozou, C. (Univ. of Sheffield, Eng.). J. Plasma Phys.; 7: No. 2, 321-8(Apr 1972).

It is shown that some recent solutions representing a dipole field immersed in an infinite plasma, which is perfectly conducting, belong to the vorticity equation in steady inviscid hydrodynamics. Further solutions of this equation, referring to the same problem, are constructed and discussed. (auth)

49546 APPLICATION OF A TWO-REGION HEAVY CHARGED PARTICLE MODEL TO NOBLE-GAS PLASMAS INDUCED BY NUCLEAR RADIATIONS. Guyot, J. C.; Miley, G. H.; Verdeyen, J. T. (Univ. of Illinois, Urbana). Nucl. Sci. Eng.; 48: No. 4, 373-86(Aug 1972).

The transport of heavy charged particles produced by the $^{10}B(n,\alpha)$ nuclear reaction is predicted using a mean-range straight-flight model. The slowing down of these particles in a gas adjacent to the coating where they are born is described in terms of their flux energy spectrum, scalar flux, average energy, and energy-loss rate. These results are used in a plasma kinetics model that is compared to measurements of metastable excited state densities in helium and neon plasmas created by the heavy charged particles. The space-dependent fast primary electron (δ ray) energy spectrum produced by the heavy charged particles in helium is calculated, as well as the total number of fast primary electrons and their average kinetic energy. (auth)

49547 HIGH-PRESSURE RECOMBINATION RATE MEASUREMENTS. Douglas-Hamilton, D. H. (Avco Everett Research Lab., Everett, Mass.). pp 591-6 of Record of the 11th Symposium on Electron, Ion, and Laser Beam Technology. /Thornley, R. F. M. (ed.). New York; Inst. of Electrical and Electronics Engineers, Inc. (1971).

From eleventh symposium on electron, ion, and laser beam technology; Boulder, Colo. (12 May 1971).

A method of generating a high-pressure, high-electron-density plasma is described and applied to measurement of electron–ion recombination rates in CO and N_2. The recombination rates are shown to be independent of pressure in the region investigated, and are given as functions of E/N. (auth)

49548 FORBIDDEN LINE INTENSITIES IN CESIUM PLASMAS. Wu, J. M.; Shaw, D. T. (State Univ. of New York, Buffalo). Energy Convers.; 12: No. 3, 77-80(Sep 1972).

Profiles of 6G–5D (l = 2) forbidden line transitions in cesium plasmas were investigated both theoretically and experimentally. The calculations were carried out based on a model which assumed the quasi-static approximation for the ion broadening effect and impact approximation for the electron effect. A 0.5 m scanning monochromator was used to measure line shapes and intensities from a cesium thermionic diode operated in the ignited mode. The electron densities were determined from the half-width of the nF−5D lines and the relative continuum radiations from 4000 to 5000 Å were used to determine the temperatures. The experimental data range in electron densities from 7.5×10^{13} to 6×10^{14} cm^{-3} and temperatures from 2000 to 3500°K, while the theoretical calculations range from 10^{13} to 1.6×10^{15} cm^{-3} for densities and 2000 to 6000°K for temperatures. It is shown that the relative line intensities ratio of 6G−5D transition to 6F−5D transition is found to be proportional to $n_e^{1.2}$. This is valid for electron densities below 4×10^{14} cm^{-3} and almost temperature independent from 2000 to 6000°K. The possible use of the forbidden line intensities for diagnostic purposes is discussed. (auth)

49549 EFFECT OF SUPERHIGHFREQUENCY NOISE SIGNAL MODULATION ON THE PROPERTIES OF THE SYSTEM PLASMA–BEAM. Levitskii, S. M.; Shapoval, V. Z. (Kiev State Univ.). Ukr. Fiz. Zh. (Russ. Ed.); 17: No. 4, 649-51(Apr 1972). (In Russian).

In modulation of an electron beam passing through plasma by an shf signal, the region of the most intensive shf oscillations is shifted in the direction opposite to that of the electron beam motion. In plasma regions under these conditions the level of shf oscillation power increases, the level of low-frequency ones (lf) (f < 30 MHz) resulting from a nonlinear interaction of shf oscillations in the system also rises. Using electron beam modulation by shf signal as an independent method to control the lf-oscillation level, the authors established that the charged particle diffusion velocity is connected with the power level of the lf oscillations excited. (auth)

49550 DEVICE FOR THE PRODUCTION OF PULSED MAGNETIC FIELDS FOR INVESTIGATIONS IN PLASMA PHYSICS. Keil, H.; Stirba, A.; Kafka, W. (to Siemens AG). German Patent 1,439,141. 20 Jan 1972. (In German).

The device described consists of a bank of parallel-connected condensers which are connected to a coil and collector plates by a low-inductance connector. This connector is bunched into groups and separated by insulating material. The shape and arrangement of the various components are also described in detail. (GF)

49551 ELECTROMAGNETIC FIELD GENERATED BY AN ELECTRIC DIPOLE IN A SPHERICAL CAVITY IMMERSED IN A NONLINEAR PLASMA. Bassanini, Piero. Atti Accad. Sci. Torino. I. Cl. Sci. Fis., Mat. Natur.; 106: No. 3, 399-410(1972). (In Italian).

The problem of determining an electromagnetic field being induced by an oscillating electric dipole within a cavity surrounded by a nonlinear ionized gas is discussed. The development showed that the wavelength generated would be small in comparison to the radius of the cavity. The final expression approximated the first of two harmonics of the field. (K.S.W.)

Kinetics (Experimental)

49552 ELECTRICAL AND OPTICAL MEASUREMENTS IN A PULSED DISCHARGE IN HELIUM I. Vagner, S. D.; Kagan, Yu. M.; Slyshov, A. G. Opt. Spectrosc. (USSR) (Engl. Transl.); 31: No. 6, 475-7(Dec 1971).

Translated from Opt. Spektrosk.; 31: No. 6, 876-80(Dec 1971).

To give a quantitative description of deionization phenomena, it is necessary to determine the plasma parameters at the end of a pulse. Such measurements are made in a pulsed discharge in helium at pressures of 2, 5, and 10 torr and for rectangular pulse current amplitudes of 0.8, 3.2, and 3.6A. The longitudinal electric field E, the electron temperature T_e, the electron density, and the density of atoms in the lower excited levels 2^1S_0, 2^1P_1, 2^3S_1, and 2^3P_{012} of helium were determined. The absolute intensities were measured for a number of lines radiated from levels with principal quantum number 3, 4, and 5, and the balance equation was verified for these levels. (auth)

49553 INTERACTION OF A STREAMING PLASMA WITH A MAGNETIC MIRROR. Kramer, William R.; Siambis, John G. (Carnegie-Mellon Univ., Pittsburgh). Phys. Fluids; 15: No. 9, 1652-7(Sep 1972).

The interaction between a supersonically streaming plasma and a spatially increasing longitudinal magnetic field is investigated experimentally. The object of the experiment is to obtain qualitative and quantitative data on this interaction and, in particular, the transition from supersonic to subsonic flow and the attendant shock formation. It is shown that for distances in excess of 50 cm from the gun, where the plasma beam is formed, to the peak of the mirror field and for values of peak mirror field exceeding 3 kG, a supersonic–subsonic flow transition does occur and a shock is formed. The helium plasma beam is produced by a conical theta-pinch gun driven by a capacitor bank with a stored energy of 2.5 kJ. Measurements are made of the plasma density, temperature, and streaming velocity. The experimental results are compared to and found in qualitative agreement with an existing theory which predicts the parameter values for the formation of a shock in a related geometry. (auth)

49554 SPECTROSCOPIC STUDIES OF THE EMISSION FROM PLASMAS GENERATED BY AN INTENSE ELECTRON BEAM. Carlson, G. A. (Sandia Labs., Albuquerque, N. Mex.). pp 121-30 of Record of the 11th Symposium on Electron, Ion, and Laser Beam Technology. /Thornley, R. F. M. (ed.). New York; Inst. of Electrical and Electronics Engineers, Inc. (1971).

From eleventh symposium on electron, ion, and laser beam technology; Boulder, Colo. (12 May 1971).

A high-temperature materials research program is being established at Sandia Laboratories using a Nereus pulsed electron-beam generator as an energy source. The present study was undertaken to develop spectroscopic techniques which might be useful in this research program. An additional goal of this study was to identify the species responsible for the intense light emission observed when pulsed electron beams are transmitted through a gas. (auth)

49555 EXPERIMENTAL STUDY OF ELECTRON AND ION HEATING IN HIGH-β PERPENDICULAR COLLISIONLESS SHOCK WAVES. Keilhacker, M.; Kornherr, M.; Niedermeyer, H.; Steuer, K.-H. (Max-Planck-Institut fuer Plasmaphysik, Garching, Ger.). pp 327-34 of Cosmic Plasma Physics. /Schindler, Karl (ed.). New York, Plenum Publishing Corp. (1972).

From Conference on cosmic plasma physics; Frascati, Italy (20 Sep 1971). See CONF-710951.

Collective dissipation in collisionless shock waves was investigated in two theta-pinch experiments. They supplemented each other in such a way that the plasma parameters decisive for the onset of certain instabilities leading to microturbulence and collective dissipation could be varied over a wide range. In the "turbulent-heating" experiment (coil diameter 16 cm) the shock waves propagated into an initial deuterium plasma of density $n \approx 3 \times 10^{14}$ cm^{-3} produced by a fast theta pinch. The characteristic parameters were $\beta \approx 1$, $T_e/T_i \approx 0.2$, $\omega_{pi}/\omega_{ce} \approx 1$. Quasi-stationary shock waves could be generated for Mach numbers ranging from 1.5 to 5. Time-resolved laser scattering showed strong collisionless electron heating accompanied by density fluctuations that were up to 250 times thermal. The frequency and wave number spectra as well as the angular distribution of this turbulence were measured. The turbulence seemed to originate from electron cyclotron waves driven by the diamagnetic current in the shock front. For supercritical Mach numbers strong ion heating was observed. In the "MINIMAX" device (coil diameter 43 cm) an initial plasma of density $n = 5 \times 10^{11}$ to 5×10^{12} cm^{-3} was generated by uv radiation. The characteristic parameters were $\beta \approx 10^{-2}$, $T_e/T_i > 1$, $\omega_{pi}/\omega_{ce} = 0.02 - 1$. Fast magnetic and electric miniature probes and the observation forbidden-line satellites were used to investigate electric and magnetic field fluctuations occuring during the fast compression of the plasma. The satellite measurements yielded an amplitude of the fluctuating electric fields of about 5 kV/cm and an energy density corresponding to about 1% of the thermal energy of the electrons. During the early compression phase strong coherent magnetic fluctuations with frequencies up to 200 MHz were observed. (auth)

49556 DETERMINATION OF CRITICAL ELECTRON DENSITY FOR THE ESTABLISHMENT OF LTE IN ARGON PLASMAS. Pichler, G.; Vujnovic, V. (Univ., Zagreb). Phys. Lett.; 40A: No. 5, 397-8(14 Aug 1972).

Oscillator strengths of Ar I lines were measured in a certain interval of electric currents in an argon cascade arc in order to determine the critical electron density necessary for the establishment of LTE in argon plasmas. (auth)

49557 TURBULENCE IN THETA-PINCH PLASMA WITH AZIMUTHAL MAGNETIC FIELD. El-Khalafawy, T. A.; Youssef, A. M.; Demchenko, V. V.; Diatlov, V. G. (Atomic Energy Authority, Cairo). Phys. Lett.; 40A: No. 5, 409-11(14 Aug 1972).

It was demonstrated that a small-scale drift instability occurs in a theta pinch with a superimposed azimuthal magnetic field, subsequently resulting in turbulization of oscillations and heating of the plasma. The data obtained agree well with the available theoretical models. (auth)

Kinetics (Theoretical)

Refer also to abstract 48669.

49558 (AD-738821) FLUID MODELS FOR TOKAMAK PLASMAS. Final Report. Duechs, Diethelm (Naval Research Lab., Washington, D. C.). 22 Feb 1972. 40p. (NRL-7340). NTIS.

The tokamak system is a toroidal electromagnetic field plasma configuration in which the magnetic field ratio B_z/B_θ is large. This toroidal configuration, which is one of the simpler magnetic confinement geometries, has led to relatively high plasma temperatures, densities, and containment times. The growing amount of experimental data, which needs to be explained, reveals the need for complicated theoretical plasma models similar to those which have been applied to pinch plasmas over the past several years. It does not seem possible to explain the experimental data by using the present two-fluid model applying the usual (classical) transport coefficients. Two major model expansions are obvious: (a) increase the number of fluids in the model, and (b) take into account as many spatial dimensions as possible. A fluid model that includes neutrals, electrons, and ions with arbitrary charge Z is derived. Cylindrical symmetry is imposed, although the transport coefficients include corrections for toroidal geometry. Assumptions are discussed under which this model can be applied to describe a tokamak plasma consisting of neutral hydrogen, protons, electrons, and nine ionization stages of oxygen impurities. (auth) (NTIS)

49559 (COO-2181-8) EFFECTS OF NONADIABATIC TRANSITIONS ON INVARIANTS OF THE MOTION. Aamodt, R. E. (Colorado Univ., Boulder. Dept. of Astro-Geophysics); Jaeger, E. F. (National Center for Atmospheric Research, Boulder, Colo.). Jul 1972. Contract AT(11-1)-2081. 15p. Dep. NTIS.

A computer study is made of the change in adiabatic invariant for a single pendulum when a slow variation in the pendulum length forces the pendulum to change from a uniformly rotating motion to an oscillating state. The numerical results are shown to be in good agreement with a simple analytic approximation which itself is generalizable to calculations of nonadiabatic transitions in other, physically more interesting problems. (auth)

49560 (LA-4823) NUMERICAL SOLUTION OF THE BOLTZMANN EQUATION FOR ENERGY DISTRIBUTIONS OF ELECTRONS WITH INELASTIC SCATTERING ON MOLECULES. Hancock, J. H.; Jones, R. C.; Mills, C. B. (Los Alamos Scientific Lab., N. Mex.). May 1972. Contract W-7405-eng-36. 70p. Dep. NTIS.

A new integration of the second-order Boltzmann equation for electron energy conservation in a gaseous electronic plasma, with large inelastic scattering cross sections, was accomplished. The procedure was to solve a system of numerical equations approximating the differential equation by using the tridiagonal matrix form resulting from a first-order expansion of the terms of the equation in energy space. The results of the integration showed excellent self-consistency in energy balance, and gave significantly different excitation rate integrals from previous solutions. A FORTRAN computer code for the CDC 6600 is appended to the report. (auth)

49561 (UCRL-73932) PLASMA FOCUS-SOLID TARGET INTERACTIONS. Freeman, Bruce; Luce, John; Sahlin, Harry (California Univ., Livermore. Lawrence Livermore Lab.). 17 May 1972. 6p. (CONF-720804-1). Dep. NTIS.

From fifth European conference on controlled fusion and plasma physics; Grenoble, France (21 Aug 1972).

In an attempt to get a zero-order approximation of the behavior of matter in a plasma focus, a one-dimensional computer calculation was performed. (auth)

49562 DYNAMIC SHIELDING EFFECTS IN PARTIALLY IONIZED GASES. Hahn, Hong-sup (Brown Univ., Providence); Mason, E. A.; Miller, E. J.; Sandler, S. I. J. Plasma Phys.; 7: No. 2, 285-92(Apr 1972).

The effects of dynamic shielding of charged-particle interactions on the predicted values of the transport properties of partially ionized argon are considered. It is found that, at low degrees of ionization, dynamic shielding effects are of little importance, because charged-particle encounters are infrequent, so that the perturbed Lorentzian method may be used to obtain a rapidly convergent solution. At higher degrees of ionization, where the Chapman–Enskog solution converges rapidly, dynamic shielding effects can be taken into account using the expressions presented in the appendix to this paper. It is also found that the static shielding model, assuming complete shielding by electrons only, yields results that are quite close to those obtained when dynamic shielding is considered. (auth)

49563 NONLINEAR MOTIONS AND TRAPPING OF PARTICLES IN A QUASI-MONOCHROMATIC WAVE. Klima, R. (Inst. of Plasma Physics, Prague). J. Plasma Phys.; 7: No. 2, 329-36 (Apr 1972).

An asymptotic solution is given of the particle motion in an arbitrary quasi-monochromatic wave. Zero stationary magnetic field and untrapped particles are considered. The number of adiabatically trapped particles, the total momentum conservation and the space-averaged distribution function of nonresonant particles are derived for the case of an electrostatic wave with time-dependent amplitude. (auth)

49564 DERIVATION OF THE QUASILINEAR EQUATIONS. Fukai, Junichiro; Harris, Edward G. (Univ. of Tennessee, Knoxville). J. Plasma Phys.; 7: No. 2, 313-20(Apr 1972).

A derivation of the quasi-linear equations is given, which is sufficiently general to include damped waves. The cause of some difficulties in previous derivations, momentum and energy conservation, and the origin of irreversibility are discussed. (auth)

49565 IMPROVED HIERARCHY FOR TURBULENT MAGNETIZED PLASMA. PART 1. THEORY. Linnebur, Eldon J.; Kammash, Terry (Univ. of Michigan, Ann Arbor). J. Plasma Phys.; 7: No. 2, 337-62(Apr 1972).

The kinetic equations for infinite homogeneous turbulent plasma in a magnetic field are analyzed using a projection operator which allows the time dependence to be maintained in a more exact and consistent manner than has been possible heretofore. By introducing approximations on the multi-time correlation function rather than the fluctuations, as is conventionally done, a hierarchy of equations is obtained which predicts different behavior for the system especially in connection with wave–wave interactions. These effects are further highlighted by showing how the present results reduce to those obtained by various authors. (auth)

49566 IMPROVED HIERARCHY FOR TURBULENT MAGNETIZED PLASMA. PART 2. APPLICATION TO RESONANT THREE-WAVE INTERACTIONS. Linnebur, Eldon J.; Kammash, Terry (Univ. of Michigan, Ann Arbor). J. Plasma Phys.; 7: No. 2, 363-71(Apr 1972).

The resonant three-wave interactions in an infinite homogeneous magnetized plasma are re-examined using the improved hierarchy presented in part 1. An equation for the wave energy is obtained which, for a spectrum made up entirely of marginally stable waves, is shown to be a second-order Markoffian differential equation, rather than a first-order equation as obtained by others. The conditions under which a first-order equation is derived are examined and discussed. For a spectrum composed of waves with small growth rates, it is shown that the equation for the plasmon density always has a stationary solution, thus eliminating the occurrence of an "explosive instability" in such systems. (auth)

49567 SUPERADIABATICITY IN MIRROR MACHINES. Rosenbluth, Marshall N. (Inst. for Advanced Study, Princeton, N. J.). Phys. Rev. Lett.; 29: No. 7, 408-10(14 Aug 1972).

At low fluctuation levels the small changes in magnetic moment induced by resonant electrostatic modes are nonrandom and do not lead to particle loss. (auth)

49568 FREE BOUNDARY SOLUTION OF A CURRENT-CARRYING PLASMA. Yoshikawa, S. (Princeton Univ., N. J.). Phys. Fluids; 15: No. 9, 1638-4(Sep 1972).

The effect of the externally imposed field error on the shape of the current-carrying plasma is considered. It is found that the ratio of the perturbation to the plasma size is of the order of $B_e/(B_a m)$, where B_e is the perturbed field and B_a is the field of the plasma current. (auth)

49569 INTENSE RELATIVISTIC ELECTRON BEAM-PLASMA INTERACTIONS IN FINITE CAVITIES. Putnam, Sidney (Physics International Co., San Leandro, Calif.). pp 561-76 of Record of the 11th Symposium on Electron, Ion, and Laser Beam Technology. /Thornley, R. F. M. (ed.). New York; Inst. of Electrical and Electronics Engineers, Inc. (1971).

From eleventh symposium on electron, ion, and laser beam technology; Boulder, Colo. (12 May 1971).

Intense relativistic electron-beam propagation in neutral gas-filled drift chambers has been studied experimentally over the past several years. Depending on gas pressure and beam parameters, one observes, for example, regions of ion acceleration, relatively efficient beam transport, or highly unstable behavior. To understand these different regimes, one must consider the time-varying electromagnetic (EM) beam–cavity interactions with boundary conditions appropriate to experimental configurations, as well as the beam dynamics. The full self-consistent problem is extremely complex, involving charge production processes and coupled EM-orbit equations and is probably ultimately amenable only to numerical solution. Nevertheless, most of the gross beam behavior can be understood with simple models. EM fields generated by beams in finite cavities and a procedure to calculate charge production in neutral gases which gives gas breakdown times in agreement with the data of Yonas and Spence are discussed. The electrostatic field effects on low-pressure beam propagation are considered in some detail and a model for predicting transverse instability wavelengths is also given. Throughout the discussion simple formulations of the important beam physics are emphasized. (auth)

49570 RESONANT DIFFUSION IN STRONGLY TURBULENT PLASMAS. Birmingham, T. J. (Goddard Space Flight Center, Greenbelt, Md.); Bornatici, M. pp 311-17 of Cosmic Plasma Physics. /Schindler, Karl (ed.). New York, Plenum Publishing Corp. (1972).

From Conference on cosmic plasma physics; Frascati, Italy (20 Sep 1971). See CONF-710951.

The Vlasov equation for an unmagnetized plasma is solved in the weak coupling limit by using perturbed particle orbits as characteristic trajectories. It is shown that the ensemble average of the one-particle distribution function satisfies a diffusion equation in velocity space. The diffusion coefficient is, in general, an integral functional of the second-order correlation of the turbulent field along the perturbed particle orbits. For stationary and homogeneous turbulence, and in the approximation of diffusive particle orbits, the diffusion coefficient for resonant particles is given asymptotically in time. If the level of turbulence is below a critical value the well-known result of the quasi-linear theory for the resonant velocity diffusion coefficient follows. For strong turbulence it is shown that $D \propto (\delta E)^{4/3}$, instead of the $(\delta E)^2$ dependence for weak fields. (auth)

49571 INFLUENCE OF DISTANT ELECTRON COLLISIONS ON THE PLASMA-BROADENED 4471.48-A He I LINE. Deutsch, C. (Laboratoire de Physique des Plasmas, Orsay, France); Coulaud, G.; Sassi, M. Phys. Lett.; 40A: No. 4, 299-300(31 Jul 1972).

The various proposals made for the long range cutoff of the impact electron broadening are tested numerically on the partially degenerate 4471 Å He I line. No significant discrepancy is found. (auth)

49572 KINETIC EQUATION FOR A DENSE CLASSICAL PLASMA. Baus, M. (Univ., Brussels). Phys. Lett.; 40A: No. 3, 213-14(17 Jul 1972).

The Balescu—Guernsey—Lenard equation for an homogeneous classical dilute electron gas is extended to higher densities. (auth)

49573 EXACT THEORY OF IONIZATION WAVES (STRIATIONS). Rohlena, K.; Ruzicka, T.; Pekarek, L. (Inst. of Physics, Prague). Phys. Lett.; 40A: No. 3, 239-41(17 Jul 1972).

A theory of the moving striations at low-currents is presented based on a direct solution of the Boltzmann equation and on the ion and metastable continuity equations. Four out of the six obtained wave-varieties are known from experiment. (auth)

49574 ENERGY LOSS OF FAST ELECTRONS AND POSITRONS IN A PLASMA. Gould, R. J. (Univ. of California, San Diego, La Jolla). Physica; 60: No. 1, 145-54(Jul 1972).

The stopping power of a plasma for fast electrons and positrons is calculated. First, the classical limit is considered where $\beta = v/c \ll \alpha$ is the fine structure constant. Then the nonrelativistic Born-approximation formulas are derived; this domain corresponds to $\alpha \ll \beta \ll 1$. Finally, the general case of relativistic electrons and positrons is treated; in the relativistic case the scattering cross sections of Møller (electron—electron) and Bhabha (positron—electron) are used in the calculation. In all three energy domains the problem is broken up into cases of small and large momentum transfers ($\hbar q$). For large q, scattering off individual plasma electrons is considered, while in the limit of very small q for the quantum-mechanical domain, excitation of quantized plasma oscillations contributes to dE/dx; in the classical limit for small q (or large impact parameter), the polarizability of the plasma provides the effective cutoff. The formulas for the stopping power differ slightly from those for a heavy ion going through a plasma because (i) there are exchange effects and (ii) the fast electrons and positrons can lose a large fraction of their energy in one scattering off a plasma electron. (auth)

49575 UNIFIED QUANTUM STATISTICAL FORMULATION OF PRESSURE BROADENING. Voslamber, Dietrich (CEN, Fontenay-aux-Roses, France). Phys. Lett.; 40A: No. 3, 266-8 (17 Jul 1972).

BBGKY techniques are employed to derive the intensity distribution of radiating particles perturbed by a surrounding gas of neutrals or plasma electrons. For the case that simultaneous strong collisions are negligible, a line-shape formula is obtained that is valid over the whole profile (also for frequency separations exceeding kT/h), provided that the frequency domain considered is still far from the neighboring lines. (auth)

49576 SHORT-DISTANCE BEHAVIOR OF THE PAIR CORRELATION FUNCTION FOR CLASSICAL PLASMAS. Cooper, M. S. (Univ. of California, Berkeley); DeWitt, H. E. Phys. Lett.; 40A: No. 5, 391-2(14 Aug 1972).

The screening effects on two like charges at short distances in a classical plasma are computed using a cluster expansion for the pair correlation function. Numerically accurate results are obtained for the intermediate screening region, $\Lambda \sim 1$, where Λ is Coulomb interaction parameter. (auth)

Production

Refer also to abstracts 48501, 48509, and 48520.

49577 (AD-738870) PRODUCTION OF THERMONUCLEAR PLASMAS BY ANOMALOUS DIFFUSION OF MAGNETIC FIELDS IN A HIGH-VOLTAGE THETA PINCH. Annual Summary Report, November 1970—November 1971. (Maryland Univ., College Park. Dept. of Physics and Astronomy). Nov 1971. Contract N00014-67-A-0239-0015. 63p. NTIS.

The report describes work being performed at the University of Maryland on understanding collisionless dissipation mechanisms operative when a large-amplitude magnetic pulse is applied to a low-density magnetized plasma; it covers the period November 1970 to November 1971. Emphasis was on understanding the details of instabilities occurring in the fast theta-pinch device and on acquiring measurements of quantities (fluctuating electric fields, ion particle distributions) that could be compared to theory). (auth) (NTIS)

49578 (COO-3547-2) PRODUCTION OF PLASMAS FOR THERMONUCLEAR RESEARCH BY LASER BEAM IRRADIATION OF SOLID PARTICLES. Semiannual Report, January 31, 1972—July 31, 1972. Haught, Alan F.; Polk, Donald H.; Woo, James T.; Fader, Walter J.; Tomlinson, Richard G.; Haas, Roger A. (United Aircraft Corp., East Hartford, Conn. Research Labs.). Jul 1972. Contract AT(11-1)-3547. 48p. (UARL-L-920365-17). Dep. NTIS.

High-temperature, high-density plasmas produced in vacuum within a magnetic containment field by laser beam irradiation of an isolated, small solid particle are being utilized in a program to examine in detail the high-β capture, transition to mirror confinement, and subsequent decay of a minimum-B, mirror-confined plasma in the high density regime of CTR interest. This program is based on and is a direct extension of the production, heating, and magnetic field capture and confinement investigations of laser-produced plasmas which have been carried out. These earlier studies have shown that laser irradiation of a small solid particle in vacuum is an effective means of producing an isolated, uncontaminated, fully ionized plasma at high density and temperature. Additional theoretical and experimental investigations have been made of such plasmas formed within simple mirror and minimum-B magnetic containment fields. Magnetohydrodynamic calculations which approximate the effects of the magnetic field on the plasma development show that the initial plasma expansion is unaffected by the field but that the expansion is later slowed and the plasma stopped when the energy density of the expanding plasma has decreased to that of the surrounding magnetic field. Flux coil measurements confirm these plasma capture calculations, and additional experiments with mirror magnetic fields have established that, upon diffusion of the magnetic field into the plasma, the plasma is mirror confined and, in minimum-B fields with sufficiently large field gradient, decays with a lifetime consistent with Coulomb collisional decay into the magnetic field mirror loss cones. (auth)

49579 (UCRL-Trans-10620) STUDY OF THE INITIAL PHASE OF BREAKDOWN OF A GAS BY LASER. Chalmeton, V. Translated for Univ. of California Lawrence Livermore Lab., Livermore, from J. Phys. (Paris); 30: No. 8-9, 687-99(1969). 37p. Dep. NTIS.

Experimental results obtained in various gases, especially H_2 and CO_2 with a proportional counter, show that free electrons appear at the focal spot for laser powers much below the threshold for optical gas breakdown. The variations of the appearance threshold of these electrons are not in line with the assumption of a highly nonlinear (multiphoton) effect. An effect on the order 1 or 2 seems to agree with the experimental results for high pressures. (auth)

49580 (UCRL-Trans-10621) PRODUCTION OF HOT PLASMAS OF SOLID-STATE DENSITY WITH ULTRASHORT LASER PULSES. Salzmann, H. (Max-Planck-Institut fuer Plasmaphysik, Garching (West Germany)). Translated for Univ. of California Lawrence Livermore Lab., Livermore, from report IPP-IV-23. 42p. Dep. NTIS.

An investigation was made of the energy transfer through electron thermal conduction with higher per-unit-area doses. The question of the energy coupling was excluded from the study. A criterion is derived as to when an input of energy over finite lengths of time can be expected to produce heat waves in the unperturbed target material. (auth)

49581 REASONS FOR THE COLLISIONLESS NATURE OF INTERACTIONS IN A LASER-PRODUCED PLASMA EXPERIMENT. Dean, S. O.; McLean, E. A.; Stamper, J. A.; Griem, Hans R. (Naval Research Lab., Washington, D. C.). Phys. Rev. Lett.; 29: No. 9, 569-73(28 Aug 1972).

Experimental and theoretical evidence is presented to substantiate the collisionless nature of the interaction reported previously. Arguments claiming that the observed phenomena were collisional are discussed. (auth)

Stability

Refer also to abstract 49507.

49582 (AD-738218) LITERATURE SURVEY ON PLASMA INSTABILITIES. VOLUME II. ABSTRACTS. PART C. Auer, Gerhard; Cap, Ferdinand; Floriani, Dietmar; Gratzl, Herbert; Weil, J. (Innsbruck Univ. (Austria). Institut fuer Theoretische Physik). 15 Aug 1971. Contract F61052-70-C-0014. 221p. (UNICP-SR-83). NTIS.

Vol. 1 gives single reports surveying plasma instabilities. It contains 121 single reports and a subject index (list of instabilities) enabling the reader to find the survey report on a special instability. Vol. 2 consists of several parts and contains all abstracts made. An index at the end of Volume 2 enables one to find all abstracts belonging to a specified instability. (NTIS)

49583 (CEA-CONF-2014) LECTURE TO THE SHERWOOD THEORY MEETING [ON MHD EQUILIBRIUM]. Mercier, C. ([Commissariat a l'Energie Atomique, Fontenay-aux-Roses (France). Centre d'Etudes Nucleaires]). Mar 1972. 7p. (CONF-720330-1). Dep. NTIS (U. S. Sales Only).

From Sherwood theory meeting; Los Alamos, NM. (23 Mar 1972).

The class of localized perturbations of magnetohydrodynamic equilibrium states is discussed. A brief analysis is given for toroidal fields with circular cross sections. (M.O.W.)

49584 (COO-2168-3) MICROINSTABILITIES OF FINITE MIRROR-CONFINED PLASMAS. Annual Progress Report, September 1, 1971-May 31, 1972. Callen, James D.; McCune, James E. (Massachusetts Inst. of Tech., Cambridge (USA). Lab. for Plasma Physics). Jun 1972. Contract AT(11-1)-2168. 9p. Dep. NTIS.

Brief summaries of research are given for the following topics: (1) modified negative mass instability, (2) enhanced scattering inherent to loss cone particle distributions, and (3) radial eigenvalue problem for drift-cone modes. (M.O.W.)

49585 (NYO-1480-182) ENERGY PRINCIPLE WITH SPECIFIC INDUCTANCE. Bateman, Glenn (New York Univ., N. Y. Courant Inst. of Mathematical Sciences). Jul 1971. Contract AT(30-1)-1480. 47p. (MF-75). Dep. NTIS.

The stability conditions for a scalar pressure, toroidal plasma are formulated by means of an energy variational principle in which the geometric problem of variation of the flux surface shapes is separated from the variation of the flux profile. By means of successive minimizations, holding the surface shapes and the flux profiles fixed, the potential energy is written as a one-dimensional integral over a function of pressure, differential flux, and the specific inductance matrix. The latter depends upon only the geometry of the surfaces. Stability conditions are derived by varying the flux profile and the geometry (specific inductance). Also, a nonlinear condition is derived for the special case of finite geometric distortions of the flux surfaces holding the flux profiles fixed. Exact results for the specific inductance are calculated for straight cylinders, axisymmetric toruses, and helically symmetric configurations, all with arbitrary cross sections. (auth)

49586 (ORNL-4793, pp 1-9) PLASMA THEORY AND COMPUTATION. (Oak Ridge National Lab., Tenn.). Aug 1972.

In Thermonuclear Division annual progress report, 1971.

Theoretical work is directed mainly toward support of the experimental programs in: (1) magnetic mirror confinement, (2) confinement and heating in the ORMAK device, and (3) the new high-beta ELMO Bumpy Torus proposal. One-dimensional transport models were used to study the time evolution of Tokamak discharges with Ohmic heating from energetic neutral atom injection. (M.O.W.)

49587 STABILITY OF PLASMA IN A HELICAL FIELD. Pant, M. M. (Th D S B Govt. Coll., Naini Tal, India). Agra Univ. J. Res.; 19: No. 2, 67-75(1970).

The stability of plasma in a helical field is considered by using the method of small perturbations. The plasma is assumed to be confined in a helical magnetic field with cylindrical symmetry along the z axis in the presence of external gravity acting along the r direction. The cylindrical column is assumed to extend to infinity along the z direction and has a finite radius. To this inviscid, incompressible infinitely conducting column, an irrotational, nonsymmetric velocity perturbation is applied to obtain the initial perturbed equation of the problem. (Indian Sci. Abstr.)

49588 ORDINARY-MODE ELECTROMAGNETIC INSTABILITY FOR COUNTER-STREAMING PLASMAS WITH ANISOTROPIC TEMPERATURES. Gaffey, J. D. (Univ. of California, San Diego); Thompson, W. B.; Liu, C. S. J. Plasma Phys.; 7: No. 2, 189-206(Apr 1972).

The instability of the ordinary electromagnetic mode propagating perpendicular to an external magnetic field is studied for two counterstreaming plasmas with anisotropic temperatures. A necessary and sufficient condition for this instability is derived and the growth rate is calculated. Comparison with the electrostatic two-stream instability is made. (UK)

49589 FLUTE INSTABILITY IN A Q-MACHINE. D'Ambrogio, Enos; Nocentini, Aldo (Univ., Trieste, Italy). J. Plasma Phys.; 7: No. 2, 247-53(Apr 1972).

The influence of the cathodes of a double-ended Q machine on a flute instability of the Rayleigh–Taylor type is investigated for a low-β plasma column. It is shown that flute modes are strongly affected by the end plate conditions and by the machine length. The occurrence of ion-rich sheaths is a necessary condition for the validity of the dispersion relation of the unbounded case. The range of values of the column length for the existence of a given flute mode is determined. (auth)

49590 LARMOR RADIUS AND COLLISIONAL EFFECTS ON THE DYNAMIC STABILITY OF A COMPOSITE MEDIUM. Bhatia, P. K. (Monash Univ., Clayton, Australia); Steiner, J. M. Aust. J. Phys.; 25: No. 3, 259-64(Jun 1972).

The combined effects of a finite ion Larmor radius and collisions with neutral atoms on the dynamic stability of a composite medium are investigated. The stability analysis is carried out for a semi-infinite composite medium of variable density in the presence and absence of a uniform streaming motion. Wave propagations transverse to the direction of the uniform horizontal magnetic field are considered. It is found that the effects of the collisions as well as the finite ion Larmor radius are stabilizing on both streaming and nonstreaming composite media. (auth)

49591 NUMERICAL SIMULATION OF THE HARRIS INSTABILITY IN TWO DIMENSIONS. Gitomer, S. J.; Forslund, D. W.; Rudsinski, L. (Los Alamos Scientific Lab., N. Mex.). Phys. Fluids; 15: No. 9, 1570-7(Sep 1972).

The electrostatic Harris instability arising from a bi-Maxwellian electron velocity distribution in the presence of a uniform magnetic field is studied linearly by numerically solving the electrostatic dispersion relation and nonlinearly by two dimensional electrostatic numerical simulation. Contour plots of growth rate in $k_\perp - k_{||}$ space for a range of ω_p/Ω_c and $T_\perp/T_{||}$ are used to summarize the linear theory. With the initial conditions $T_\perp \neq 0$ and $T_{||} = 0$ the numerical simulations show the nonlinear development with $T_{||}$ increasing the $T_\perp$ decreasing until $T_\perp/T_{||} \sim 3$ which is the practical stability boundary from linear theory. The saturation level of the electrostatic field energy is very small being 0.06% of the total kinetic energy consistent with the predictions of a simple nonlinear theory. (auth)

49592 EFFECTS OF PARALLEL WAVELENGTH ON THE COLLISIONAL DRIFT INSTABILITY. Schlitt, L. G.; Hendel, H. W. (Princeton Univ., N. J.). Phys. Fluids; 15: No. 9, 1578-89(Sep 1972).

An extensive investigation of the dependence of drift wave characteristics upon parallel wavelength in collisional potassium Q-machine plasmas is presented. Results are compared with a two-fluid slab-model theory which includes the effects of parallel resistivity and thermal conductivity for electrons and Larmor radius, collisional viscosity, and motion parallel to the magnetic field for ions. The general stability characteristics of the drift wave are confirmed: stability at low magnetic field ($B/k_\perp \lesssim 0.4$ kG · cm) due to ion viscosity, stability at both long- and short-parallel wavelength ($\lambda_{||} \gtrsim 200$ and $\lambda_{||} \lesssim 100$ cm, respectively) due to the combined effects of ion viscosity and parallel electron fluid expansion and stability of individual modes at high magnetic field ($B/k_\perp \approx 1$ kG · cm, $\lambda_{||} \approx 100$ cm) due to ion parallel motion. Quantitative agreement between experiment and theory is demonstrated for the detailed parametric dependences of instability onset, complex frequency, and oscillation amplitude on parallel wavelength, magnetic field, and density. (auth)

49593 TRANSVERSE VELOCITY SHEAR INSTABILITIES WITHIN A MAGNETICALLY CONFINED PLASMA. Jassby, D. L. (Princeton Univ., N. J.). Phys. Fluids; 15: No. 9, 1590-1604 (Sep 1972).

Strong shear in the plasma rotation is produced in the interior of a magnetically confined Q-machine plasma column by means of an externally controlled nonuniform radial electric field. Coherent low-frequency oscillations are observed localized in the velocity shear layer, which contains up to seven ion gyroradii. The observed oscillations are shown to result from the transverse Kelvin–Helmholtz instability by the good agreement with finite-Larmor-radius fluid theory for the mode frequencies, radial dependences of the potential and density fluctuations, and the mode structure at large magnetic field and small rotation. At large electric fields the low-frequency Kelvin–Helmholtz modes are completely suppressed. Simultaneously, there appear oscillations with $\omega \lesssim \omega_c$, whose properties are described by the fluid equations when extended to arbitrary rotation and wave frequencies. (auth)

49594 NONLINEAR SATURATION OF THE ION-ACOUSTIC INSTABILITY. Sleeper, Arthur; Weinstock, Jerome; Bezzerides, Bandel (National Oceanic and Atmospheric Administration, Boulder, Colo.). Phys. Rev. Lett.; 29: No. 6, 343-5(7 Aug 1972).

A nonlinear theory is presented for the saturation of the current-driven ion-acoustic instability. The saturation mechanism is the modification of ion orbits by finite-amplitude waves, leading to ion trapping. The results are quantitatively compared with recent computer simulations of Biskamp and Chodura, and experiments of Hamberger and Jancarik. (auth)

49595 TRAPPED-ION INSTABILITIES IN ION-ACOUSTIC WAVE. Ikezi, H. (Nagoya Univ., Japan); Kiwamoto, Y.; Nishikawa, K.; Mima, K. Phys. Fluids; 15: No. 9, 1605-12(Sep 1972).

Growth of two types of sideband waves was observed experimentally when a relatively large-amplitude ion-acoustic wave propagates in a collisionless plasma having the electron-to-ion temperature ratio $T_e/T_i \approx 20$. The observed frequency spectrum and growth rate, as well as the frequency and amplitude ranges of the large-amplitude wave for which the sideband wave growth is observed are in good agreement with the theory of trapped particle instabilities. The sidebands extract the energy from the large-amplitude wave and cause it to be heavily damped. (auth)

49596 NONLINEAR EVOLUTION OF LOSS-CONE FLUTE MODES. Eldridge, Owen (Univ. of Knoxville, Tenn. Oak Ridge National Lab., Tenn.); Crume, E. C.; Meier, H. K. Phys. Fluids; 15: No. 9, 1679-82(Sep 1972).

An analytic theory is developed that explains the results of a recent computer simulation of loss-cone flute modes. (auth)

49597 ION-ACOUSTIC INSTABILITY OF A COLLISIONAL PLASMA WITH NONSTATIONARY EQUILIBRIUM. McBride, J. B. (Naval Research Lab., Washington, D. C.); Chu, T. K. Phys. Fluids; 15: No. 9, 1682-3(Sep 1972).

A long-wavelength ion-acoustic instability of a fully ionized, two-temperature ($T_e > T_i$), collisional plasma without sources and sinks is of no practical importance since it can e fold, at most, only once before $T_e \simeq T_i$ due to collisional relaxation of the two-temperature equilibrium. (auth)

49598 PARAMETRIC INSTABILITIES IN INHOMOGENEOUS MEDIA. Rosenbluth, Marshall N. (Inst. for Advanced Study and Plasma Physics, Lab., Princeton, N. J.). Contract AT(11-1)-3237. Phys. Rev. Lett.; 29: No. 9, 565-7(28 Aug 1972).

The theory of the three-wave parametric instability for weakly inhomogeneous media is derived with an application to laser pellet irradiation. (auth)

49599 TRANSVERSE INSTABILITIES IN FINITE-GEOMETRY STREAMS. Benford, G. (Univ. of California, Irvine). Phys. Lett.; 40A: No. 4, 305-6(31 Jul 1972).

Growth rates are calculated for the transverse instabilities in streams which have appreciable self-pinching forces. Particle drifts destabilize even cases with large applied magnetic fields. (auth)

49600 CATASTROPHIC DISRUPTION OF THE FLOW OF A MAGNETICALLY CONFINED INTENSE RELATIVISTIC ELECTRON BEAM. Friedman, M.; Hammer, D. A. (Naval Research Lab., Washington, D. C.). Appl. Phys. Lett.; 21: No. 4, 174-7(15 Aug 1972).

A disruption in the flow of an intense annular relativistic electron beam occurred when a sudden change in the radius of the drift tube walls was introduced. Experimental results showed that the electron beam (which was immersed in a homogeneous magnetic field) was under the influence of a strong nonadiabatic force which caused considerable changes in beam characteristics, such as spatial distribution and electron transverse energy. (auth)

49601 KINETIC EXCITATION OF PLASMA INSTABILITIES BY A NEARLY MONOENERGETIC BEAM. Sizonenko, V. L.; Stepanov, K. N. Izv. Vyssh. Ucheb. Zaved., Radiofiz.; 15: No. 1, 144-5(1972). (In Russian).

Silin and Rukhadze had previously demonstrated a coherent mechanism of excitation of plasma oscillations by a nearly monoenergetic beam of electrons. The present treatment of the plasma–beam system demonstrated that there also exists an effective mechanism of excitation of oscillations by resonance particles of the beam. (K.S.W.)

Thermonuclear Processes

Refer also to abstract 48823.

49602 (ANL–7932) SOME COMMENTS ON THE POWER-BALANCE PARAMETERS Q AND ϵ AS MEASURES OF PERFORMANCE FOR FUSION POWER REACTORS. Persiani, P. J.; Lipinski, W. C.; Hatch, A. J. (Argonne National Lab., Ill.). Jun 1972. Contract W-31-109-eng-38. 14p. Dep. NTIS.

Power-producing fusion-reactor systems may require a complex of plasma-producing subsystems (containment, heating, and injection) and of energy-conversion subsystems (thermal and direct). To establish a basis for a comparison of these reactor power systems, generalized definitions based on power balance are proposed for the two important power-balance parameters: (1) Q (ratio of output to input power), and (2) ϵ (fractional circulating power). The values of Q and ϵ determined from the proposed generalized definitions are compared with values in the literature based on different definitions. (auth)

49603 (ANL–7948) SOME ESTIMATES OF TRITIUM PERMEATION RATES IN THE CORE OF A D-T-FUELED FUSION REACTOR. Maroni, Victor A. (Argonne National Lab., Ill.). Jun 1972. Contract W-31-109-eng-38. 12p. Dep. NTIS.

An estimate was made of tritium permeation rates near the core of a prototypical D–T-fueled fusion-reactor power plant. Calculations based on extrapolated values for (1) tritium partial pressures over tritium solutions in lithium and (2) tritium permeation rates through candidate structural materials (i.e., vanadium and niobium) have indicated a potential method for obtaining adequate tritium recovery rates in D–T-fueled reactors with static lithium blankets. Other consequences of plant-design parameters on tritium permeation rates are discussed. (auth)

49604 (CONF-720804–2) TOKAMAK TWO-FLUID CODE: EFFECTS OF NEUTRAL BEAM HEATING, RADIATION LOSS, AND CHARGE EXCHANGE. Hogan, J. T.; Dory, R. A. (Oak Ridge National Lab., Tenn.). 1972. 4p. Dep. NTIS.

From fifth European conference on controlled fusion and plasma physics; Grenoble, France (21 Aug 1972).

Requirements for heating a large Tokamak device with energetic neutral beams are considered. Even in a pessimistic treatment one finds that ≈10 MW of supplemental injected power would produce plasma of true thermonuclear interest. Losses from radiation, plasma thermal conduction, mass transport, ionization, and charge exchange are included. (auth)

49605 (EUR-CEA-FC–631) PROBLEMS ENCOUNTERED IN THE DEVELOPMENT OF NEUTRAL PARTICLE INJECTORS: EXPERIMENTAL PROJECTS. Fumelli, M. (European Atomic Energy Community. Commissariat a l'Energie Atomique, Fontenay-aux-Roses (France). Centre d'Etudes Nucleaires). Feb 1972. 31p. (In French). Dep. NTIS (U. S. Sales Only).

The problems connected with the development of powerful neutral-particle injectors for plasma heating experiments are examined. Projects of prototype injectors employing slit-type and multi-hole accelerating systems are presented. (France)

49606 (LA-DC–72-702) PULSED HIGH-BETA FUSION REACTOR BASED ON THE THETA PINCH. Burnett, S. C.; Ellis, W. R.; Oliphant, T.; Ribe, F. L. (Los Alamos Scientific Lab., N. Mex.). 1972. 4p. (CONF-720710–2). Dep. NTIS.

From 2nd topical conference on pulsed high-beta plasmas; Garching, Germany (3 Jul 1972).

A design study of a pulsed high-beta θ-pinch reactor is presented. In the case chosen the reactor is designed to generate 1750 MW(e) with a duty factor chosen to limit the first-wall nuclear power loading to 3.5 MW/m^2. The question of energy balance is discussed and it is shown that the reactor system described has a total circulating power of less than 10%. Some advantages of a pulsed system with respect to a steady-state system are outlined. (auth)

49607 (NP–19381) RECONSTRUCTION OF THE SCREW PINCH DEVICE SP III. Rijnhuizen Report 72-69. van Heijningen, R. J. J.; Griffioen, A. C. (Stichting voor Fundamenteel Onderzoek der Materie, Jutphaas (Netherlands). Instituut voor Plasma-Fysica). Apr 1972. 27p. Dep. NTIS (U. S. Sales Only).

In the screw pinch devices at Rijnhuizen, a rapid decay of the toroidal plasma current has been observed, which eventually destroys the applied magnetic configuration. Since the loss of the poloidal magnetic flux is strongly dependent on the interaction of the plasma with the torus wall, a beneficial effect is to be expected from an improvement of the magnetic screening. Furthermore, the conservation of the poloidal flux within the plasma can be improved by a closely fitting shield around the torus, together with a suitable design of the primary toroidal circuit. To study the influence of these effects on the decay of the toroidal plasma current, the existing screw pinch device SP III was reconstructed with an improved torus, with a better magnetic screening, and with a low-inductance primary toroidal circuit. (auth)

49608 (ORNL–4793, pp 18-27) ORMAK PROGRAM. Bates, D. D.; Bean, L. G.; Berry, L. A.; (and others) (Oak Ridge National Lab., Tenn.). Aug 1972.

In Thermonuclear Division annual progress report, 1971.

ORMAK has had a period of operation at reduced fields and currents. The plasma which was produced was not diagnosed completely before the experiments were stopped to permit the completion of the systems necessary for full field operation. Construction and installation of these systems are now complete, and testing is proceeding for the second experimental phase in which the machine can operate at maximum design parameters. In the initial plasma experiments, high x-ray fluxes were observed, implying the existence of fast electrons. The question of whether or not most of the current was carried by these electrons in the first experiments is not resolved. Higher magnetic fields, implying higher density, and the provision for preionization in the second experimental phase reduce the tendency for operation in a regime of intense x-ray production. (auth)

49609 (ORNL–4793, pp 28-32) HIGH-BETA PLASMAS. (Oak Ridge National Lab., Tenn.). Aug 1972.

In Thermonuclear Division annual progress report, 1971.

The largest fraction of the experimental effort during 1971 was concentrated on the canted-mirror facility. Experimental evidence was obtained for the location and size of the high-beta annulus, the magnitude of the stored energy, and the location of the particle drift surfaces. Much of this work was included in a paper given at the I.A.E.A. meeting in Madison, Wisconsin, and is presented in abstract form. An expanded abstract is given of a document prepared on the proposed ELMO Bumpy Torus (EBT). This report contains experimental evidence from the canted-mirror facility, as well as theoretical work on the equilibrium and stability of the Bumpy Torus plasma, the power balance in the Bumpy Torus, technological aspects of the Bumpy Torus, and extrapolation of the Bumpy Torus to reactor conditions. Experimental and theoretical work on the polarization of free–free bremsstrahlung from magnetically confined plasmas is also mentioned. Numerical studies on off-resonance heating, heating studies with pulsed microwave power, and experiments on triggering of an instability by a pulsed coil in ELMO are presented. Abstracts of other papers published in 1971 are included. At present, work is continuing on the canted mirror in determining the position of the high-beta annulus, using diamagnetic and end-loss measurements. The mechanical and technological design of the EBT is continuing. Future diagnostics for the EBT are under development. (auth)

49610 (ORNL–4793, pp 49-56) MAGNETICS AND SUPERCONDUCTIVITY. Brown, R. L.; Efferson, K. R.; Gauster, W. F.; Long, H. M.; Lubell, M. S.; Luton, J. N.; Simpkins, J. E. (Oak Ridge National Lab., Tenn.). Aug 1972.

In Thermonuclear Division annual progress report, 1971.

During this year, the group concentrated its efforts on support to plasma physics programs. The IMP superconducting mirror quadrupole was installed and tested. It has been energized routinely up to 71% of the design current density of the quadrupoles and has required little attention from the group. A cryogenic system for cooldown and operation of ORMAK at liquid-nitrogen temperatures was designed. The system was fabricated and tested under group supervision and, although not completely debugged, is now operated by the ORMAK Group. Assistance in solving other cryogenic problems was provided. Magnetic design studies for the Target Plasma Group and the ELMO Bumpy Torus were initiated and carried to partial completion. Thin films of carbon and aluminum were produced for IMP and for general plasma-diagnostic studies. Other group activities included continuation of the study of stabilization of superconductors, investigation of fluctuations in boiling liquid helium, design of a 100-kG superconducting coil, tests of a 100-kG copper ribbon coil insert magnet, feasibility studies of magnets for fusion reactors, participation in a fusion feasibility workshop, survey of advanced technology in power transmission, and the layout of a cryogenic test facility. (auth)

49611 (ORNL–4793, pp 57-60) FUSION REACTOR TECHNOLOGY. Efferson, K. R.; Fraas, A. P.; Gauster, W. F.; (and others) (Oak Ridge National Lab., Tenn.). Aug 1972.

In Thermonuclear Division annual progress report, 1971.

During the past year, published work has appeared in the areas of (1) magnet design; (2) the Blascon, an exploding-pellet fusion reactor; and (3) environmental considerations. Work in progress includes: (1) a radiation damage experiment; (2) an investigation of alternate methods for recovering tritium from the breeding blanket of a fusion reactor; (3) neutron cross-section evaluations; (4) fusion reactor blanket benchmark calculations; (5) an evaluation of fusion reactors as radioactive-waste burners; (6) blanket system studies; (7) an evaluation of the engineering requirements for scatter-dominated, mirror-confined plasmas; and (8) beam technology assessments. (auth)

49612 (ORNL-TM–3794) EVALUATION OF METHODS FOR RECOVERING TRITIUM FROM THE BLANKETS OR COOLANT SYSTEMS OF FUSION REACTORS. Watson, J. S. (Oak Ridge National Lab., Tenn.). Jul 1972. Contract W-7405-eng-26. 55p. Dep. NTIS.

Potential methods for recovering tritium from the blankets or coolant systems of fusion reactors were reviewed and evaluated. The most restrictive requirement for the removal system will be prevention of an unacceptably large release of tritium to the environment. Diffusion of tritium through walls of heat exchangers into the steam turbine system is the most serious problem that must be solved since containment of tritium that reaches the steam system appears to be impractical. Based on estimates of future tritium release regulations, the study was made with a standard release rate of 4 Ci/day for a 2800-MW(e) system; however, the effects of other regulations, both more and less restrictive, were considered. The ORNL reference design featuring a potassium coolant and "topping" turbine coupled to a conventional steam turbine system was used as the basis for this study, but alternative systems that use a helium coolant and, possibly, gas turbines are discussed. (auth)

49613 (ORNL-TM–3927) ECONOMICS OF LARGE SUPERCONDUCTING TOROIDAL MAGNETS FOR FUSION REACTORS. Lubell, M. S.; Long, H. M.; Luton, J. N. Jr.; Stoddart, W. C. T. (Oak Ridge National Lab., Tenn.). Aug 1972. Contract W-7405-eng-26. 5p. (CONF-720513–13). Dep. NTIS.

From Applied superconductivity meeting; Annapolis, MD. (1 May 1972).

Earlier work (Lubell, M. S. et al., Plasma Physics and Controlled Thermonuclear Fusion Research, (IAEA, Vienna, 1971) Vol. 3, p. 433) is extended and general formulas are developed for arbitrary B_0, R, and r, for each of the cost items considered, and the total costs are determined for a variety of fields and sizes. Although not as accurate as a detailed study, the general formula developed will be useful for quickly estimating the cost of any similar toroidal system subject to the constraint $B_{max} \leq 85$ kG. The cost for any system is found to be proportional to the $^4/_5$ power of the stored magnetic energy. (M.O.W.)

49614 (UCID–15812) FUSION POWER LRL 1971. (California Univ., Livermore. Lawrence Radiation Lab.). 1971. 35p. Dep. NTIS.

A review of laboratory work is given. The review covers the following areas: (1) MFX, (2) direct conversion, (3) mirror experiments, (4) Astron, (5) superconducting levitron, and (6) high-power lasers. (M.W.O.)

49615 (UCRL–73993) MAGNETIC FIELD EFFECTS ON THE HEAT TRANSFER OF POTENTIAL FUSION REACTOR COOLANTS. Hoffman, Myron A. (California Univ., Livermore. Lawrence Livermore Lab.). 23 Jun 1972. 67p. (CONF-720912–1). Dep. NTIS.

From International school on fusion reactor technology; Erice, Italy (4 Sep 1972).

In several conceptual designs of fusion reactor containment vessels, it is proposed to use liquid lithium for the three-fold function of neutron moderator, tritium breeder and heat transfer fluid. Since the lithium must flow through a region of intense magnetic fields, it is of interest to ascertain the magnitude of the effect of the magnetic field on the heat transfer to the lithium. A previous study revealed that the magnetic field can have a very powerful and detrimental effect on lithium pumping power requirements as well as on the structural design of the blanket. This present study shows that the effects of the magnetic field on the heat transfer to liquid metals such as lithium can be severe in the regimes of interest to fusion reactors if very thin walls cannot be employed. The heat transfer capabilities of lithium are compared to those of other potential heat transfer fluids such as flibe (lithium fluoride—beryllium fluoride mixture), and high pressure helium gas. It is shown that at high Reynolds numbers, these other fluids can have higher heat transfer coefficients than liquid lithium in magnetically laminarized flow regimes. Consequently, the MHD effect on liquid metal heat transfer capabilities is one more important factor which must be taken into consideration in the choice of a suitable coolant for a fusion reactor. (auth)

49616 (UCRL–73998) SUPERCONDUCTING MAGNET REQUIREMENTS FOR FUSION REACTORS. Taylor, C. E. (California Univ., Livermore. Lawrence Livermore Lab.). 21 Jun 1972. 24p. (CONF-720513–12). Dep. NTIS.

From Applied superconductivity meeting; Annapolis, MD. (1 May 1972).

Several general approaches to controlled fusion are described. The general size and shape of the magnets for these approaches are discussed. (M.O.W.)

49617 (UCRL-Trans–10633) PICOSECOND NEODYMIUM-GLASS LASER IN THE TERAWATT RANGE. Salzmann, H. (Max-Planck-Institut fuer Plasmaphysik, Garching (West Germany)). Translated for Univ. of California, Lawrence Livermore Lab., Livermore, from report IPP–IV/21. 59p. Dep. NTIS.

The phase-coupled neodymium laser described emits laser pulses with energies of up to several joules, the pulse duration being about 10 ps. The angular divergence of the radiation is 700 μrad, i.e., with an f = 15 cm lens a focal-spot area of some 10^{-4} cm^2 can be attained. Under these conditions the intensity in the focal spot may go as high as 3×10^{15} W/cm^2. The laser consists of an oscillator, an electro-optical switch, a preamplifier chain and a main amplifier chain. In designing the oscillator, axial-mode selection of any kind was avoided in order to generate the shortest possible pulses. A single pulse is separated from the chain of ultrashort laser pulses with the fast electro-optical switch. In the process, the intensity of the remaining pulses is reduced to $^1/_{3000}$ of that of the transmitted pulse. The separated single pulse first passes twice through an initial preamplifier chain and is then mirrored into the main amplifier chain, which contains two optical insulators to attenuate the light reflected from the target in order to prevent damage to the laser. (auth)

49618 HELICAL FIELD EXPERIMENTS ON A THREE-METER THETA PINCH. Thomas, K. S.; Harder, C. R.; Quinn, W. E.; Siemon, R. E. (Los Alamos Scientific Lab., N. Mex.). Phys. Fluids; 15: No. 9, 1658-66(Sep 1972).

Small helical fields have been added to the main compression field of a 3-m long theta pinch, both by grooving the main compression coil and by adding helical windings driven by capacitor banks. The equilibrium and stability of the theta-pinch plasma column and the interference force produced by a combination of helical fields were studied and are found to be in agreement with theory. (auth)

49619 EXCITED STATE MASS ENERGY (ESME) ANALYZER. Moses, Kenneth G. (Univ. of California, Livermore. Univ. of California, Davis); Steinhaus, James F. Rev. Sci. Instrum.; 43: No. 9, 1253-7(Sep 1972).

The instrument described can quantitatively monitor the excited state populations of intense atomic beams >30 mA. The maximum mass—energy accepted by the present apparatus is 40 keV H_1^+. The ESME analyzer provides a signal proportional to the total beam particle current for comparison with the fraction of the beam atoms in excited states; the electronic system performs the comparison and automatically obtains the ratio H_1^*/H_1^0. Proposed is a possible future application of the analyzer in a feedback system for controlling the source and neutralizer components of a fusion reactor. (auth)

49620 NEUTRON PRODUCTION IN EXPLODING-WIRE DISCHARGES. Stephanakis, S. J.; Levine, L. S.; Mosher, D.; Vitkovitsky, I. M.; Young, F. (Naval Research Lab., Washington, D. C.). Phys. Rev. Lett.; 29: No. 9, 568-9(28 Aug 1972).

High-power pulse generators were used to produce dense plasmas by the explosion of thin polymer fibers. Sufficiently high ion energies were achieved to produce large neutron yields. Neutron production is attributed mainly to the reaction d(d,n)^{3}He and neutrons are observed when either fibers containing the natural abundance of deuterium or nearly fully deuterated fibers are used. Results are given which show the variation of the neutron yield with initial fiber diameter and with deuterium content. (auth)

49621 TECHNOLOGY INDEX FOR PLASMA PHYSICS RESEARCH AND FUSION REACTORS. VOLUME 6, No. 6, 1972. Bibliography, Author Index, Subject Index, Appendix. Leopoldschaften, Ger.; Zentralstelle fuer Atomkernenergie-Dokumentation (1971). 45p.

This listing contains 212 references on various aspects of the subjects. (M.O.W.)

49622 FIELD DISTRIBUTION NEAR A GAP FORMED BY SECTIONALIZED SHELLS OF A TOKAMAK-TYPE APPARATUS. Sometani, Taro; Itoh, Satoshi (Shizuoka Univ., Hamamatsu, Japan. Japan Atomic Energy Research Inst., Ibaraki). Jap. J. Appl. Phys.; 11: No. 8, 1181-6(Aug 1972).

A perturbed magnetic field distribution near a gap, which is formed by electrically conducting sectionalized shells used in a Tokamak-type plasma apparatus, is investigated analytically by making use of a Schwarz—Christoffel's transformation. The relative field distribution is dependent only on the ratio of the width of the gap to the thickness of the shell. If the presence of the gap is regarded as an edge effect and the range concerned is limited substantially within a certain distance from the edge of the shell, then it is possible to make an estimate on the absolute value of the perturbed field. The toroidal effect is considered as a perturbation to a cylindrical solution by introducing an effective eccentric distance of a plasma current with respect to the shell. A numerical calculation of the perturbed magnetic field is carried out for the dimensions of a Tokamak-type plasma apparatus (JFT-2) under construction. (auth)

49623 CONTROLLED NUCLEAR FUSION: ENERGY SOURCE OF THE FUTURE. Schotte, U. Naturwiss. Rundsch.; 25: No. 5, 185-7(1972). (In German).

A short survey is given of the ecological advantages of the three main fusion reactor concepts presently under discussion: the tokamak, the magnetic mirror, and the theta-pinch devices, like Scylla. (GF)

Wave Phenomena

Refer also to abstracts 48635 and 49566.

49624 (AD–737529) EXPERIMENTAL STUDY OF WAVE–WAVE COUPLING PROCESSES IN A BEAM–PLASMA SYSTEM. Chang, James Shih-Tsih (Illinois Univ., Urbana. Coordinated Science Lab.). Jan 1972. Contract DAAB07-67-C-0199. 96p. (R–549; UILU-ENG–72-2208). NTIS.

The wave—wave coupling processes in a cold-beam cold-plasma system were investigated under conditions such that nonlinear wave—particle effects are negligible. In this experiment, a low-density monoenergetic beam in the energy range of 15 to 16 keV was premodulated at two frequencies, f(0) = 9.5 GHz and f(1) = 9.4 GHz and injected into the afterglow of a discharge in neon. The interaction between these two launched waves and their difference frequency, f(2), was investigated and at low wave amplitudes was found to be in general agreement with the theory of the three-wave decay instability. At larger wave amplitudes, a strong remixing of the three waves occurred which gave rise to satellite waves at frequencies f(0) ± nf(2) and f(1) ± nf(2) where n is an integer. Measurements of the spatial evolution of these satellite waves and their dependence on the modulation power and difference frequency are presented. The results are discussed in the light of the theory of coupling among spatially growing waves. (auth) (NTIS)

49625 (AD–737628) COMPUTER SIMULATION OF WHISTLER TURBULENCE AND PARTICLE PITCH-ANGLE DIFFUSION IN COLLISIONLESS PLASMAS. Ossakow, S. L.; Haber, I.; Ott, E. (Naval Research Lab., Washington, D. C.). Nov 1971. 14p. (NRL-MR–2378). NTIS.

Particle-code computer simulations are used to study whistler turbulence in collisionless plasmas driven by initially anisotropic bi-Maxwellian and loss-cone electron distributions. Linear growth of magnetic energy is observed to saturate when the growth rate is of the order of the particle trapping frequency. Isotropization of the particle distribution is studied and phase space plots clearly illustrating particle pitch-angle diffusion are presented. (auth) (NTIS)

49626 (AD–737654) SELF-CONSISTENT THEORY OF WAVES IN FLUCTUATING PLASMA. Marcuvitz, N. (New York Univ., N. Y. Dept. of Electrical Engineering). Sep 1971. Contract N00014-67-A-0467-0018. 9p. NTIS.

At the microscopic level, the plasma field is described by stochastic (operator) variables determined by the nonlinear Maxwell—Klimontovitch equations. Via a perturbation-theoretic analysis, familiar from general scattering theory, one can derive from these stochastic microscopic equations the kinetic equations descriptive of the macroscopic plasma field. In a many-particle system one has to describe self-consistently both the particle dynamics and the field dynamics. (auth) (NTIS)

49627 (AD–739338) MODE COUPLING AND WAVE–PARTICLE INTERACTIONS FOR UNSTABLE ION ACOUSTIC WAVES. Martin, Pablo; Fried, Burton D. (California Univ., Los Angeles. Plasma Physics Group). Feb 1972. Contract AT(04-3)-157. 40p. (PPG–113). NTIS.

A theory for the spatial development of linearly unstable, coupled waves is presented in which both quasilinear and mode coupling effects are treated in a self-consistent manner. Steady-state excitation of two waves with frequencies ω_1 and ω_2 is assumed at the boundary $x = 0$, the plasma being homogeneous in the y and z directions. Coupled equations are derived for the x dependence of the amplitudes of the primary waves (ω_1, ω_2) and the secondary waves, $n(\omega_1) + m(\omega_2)$, (n and m being integers), correct through terms of second order in the wave amplitude, but without the usual approximation of small growth rates. This general formalism is then applied to the case of coupled ion acoustic waves driven unstable by an ion beam streaming in the direction of the x axis. (auth) (NTIS)

49628 (COO-2181-10) RADIATION COUPLING OF BERNSTEIN MODES IN DENSE PLASMAS. Interim Progress Report. Hoffman, J. (Colorado Univ., Boulder. Dept. of Astro-Geophysics). Jul 1972. Contract AT(11-1)-2081. 13p. Dep. NTIS.

A theoretical model is used to determine which electromagnetic mode is involved in the coupling process with the Bernstein mode. The characteristics of the electromagnetic mode at the plasma—vacuum boundary are studied. The effects of plasma density are also mentioned. (M.O.W.)

49629 (FTI-413) INVESTIGATION OF ELECTRIC FIELDS WITHIN AN INTERACTION OF SUPERHIGH FREQUENT WAVES WITH PLASMA BY STARK-EFFECT. Arkhipenko, V. I.; Budnikov, V. N.; Varfolomeev, V. I. (Akademiya Nauk SSSR, Leningrad. Fiziko-Tekhnicheskii Institut). 1972. 13p. (In Russian). Dep. NTIS (U. S. Sales Only).

Experimental results on the determination of electric-field amplitude within a superhigh-frequency wave absorption by plasma are presented. Plasma was created by 3-cm superhigh-frequency power supplied as H_{11} waves to the plasma balloon through the round waveguide. Input power was 100 W, and the amplitude of superhigh-frequency electric field in the waveguide within plasma was 150 V/cm. The end of the balloon had conical form. Hydrogen of 2×10^{-2} torr was the process gas. The half-widths of the H_α, H_β, H_γ lines were measured. This gave the possibility of obtaining the balloon length distribution of the radiating atom temperature and electric field amplitude. The maximum field value was 1.3 kV/cm. The strong field range was situated in the conical part and consisted of about 2 cm. (auth)

49630 (N-72-20631) RESONANCE, PARTICLE TRAPPING, AND LANDAU DAMPING IN FINITE-AMPLITUDE OBLIQUELY PROPAGATING WAVES. Palmadesso, P. J. (National Aeronautics and Space Administration, Greenbelt, Md. Goddard Space Flight Center). Mar 1972. 640p. (NASA-TM-X-65852; X-641-72-75). NTIS.

The equations of motion for a particle in resonance with a small finite-amplitude wave are solved approximately, using secularity free perturbation theory. The wave propagates at an arbitrary angle to a uniform background magnetic field in an infinite collisionless plasma. The wave fields include a longitudinal electrostatic component and elliptically polarized transverse electric and magnetic components. The trajectories of trapped and resonant untrapped particles are described for each of the possible wave—particle resonances. These trajectories are used to construct an estimate of the nonlinear time-dependent Landau damping rate of the wave. (auth) (STAR)

49631 NONLINEAR INTERACTION OF RESONANT PLASMA OSCILLATIONS. Lewak, G. J.; Ogunlana, J. (Univ. of California, San Diego). J. Plasma Phys.; 7: No. 2, 207-15(Apr 1972).

Using the water-bag model of an electron plasma, the nonlinear interaction of two plasma wave pulses (each of sufficiently narrow wave-number spectrum) is discussed. It is shown that, for the special case of a resonant (zero group velocity) pulse interacting with a nonresonant pulse, the interaction produces an effective slowing down of the group velocity of the nonresonant pulse. An application of this theory to the explanation of the apparent resonances at fractions of the plasma frequency observed in the ionosphere is discussed. (auth)

49632 INTERACTION PROCESSES IN A WEAKLY TURBULENT VLASOV PLASMA. Olbers, D. J. (Univ., Hamburg). J. Plasma Phys.; 7: No. 2, 217-34(Apr 1972).

The interaction between waves and particles in a weakly turbulent, collision-free plasma for the case of pure Coulomb interaction and zero magnetic field is considered. Starting with the Vlasov equation, a solution by means of a perturbation expansion and a diagram technique is suggested, which classifies the various interaction processes and leads to the derivation of kinetic equations. (auth)

49633 EFFECTS OF PARALLEL WAVES IN HOMOGENEOUS PLASMAS IN UNIFORM MAGNETIC FIELDS. Salu, Y. (Tel-Aviv Univ., Israel). J. Plasma Phys.; 7: No. 2, 255-66(Apr 1972).

The effects of circularly polarized plasma waves in anisotropic homogeneous plasmas are studied. The waves propagate in the direction of an external uniform magnetic field. It is shown that in many cases only one mode is present in the plasma. A computer model suitable for the study of such cases is presented. The model is used to simulate linearly stable and unstable phenomena. A good agreement with previous predictions of linear theory is obtained. Nonlinear effects are studied and mechanisms that stop instabilities are described. (auth)

49634 LAGRANGIAN THEORY FOR NONLINEAR WAVE PACKETS IN A COLLISIONLESS PLASMA. Dewar, R. L. (Univ. of Maryland, College Park). J. Plasma Phys.; 7: No. 2, 267-84(Apr 1972).

A Lagrangian, for the slowly varying complex amplitude of an almost monochromatic electrostatic plasma wave in an unmagnetized plasma, is derived. The method is a variant of the averaged Lagrangian technique of Whitham, adapted for use in plasma physics by employing Low's Lagrangian, together with certain elimination procedures to simplify the Lagrangian to usable form. The expansion in powers of the wave amplitude is carried out to quartic terms, and nonadiabatic terms are also retained. Variations with respect to the amplitude lead to a nonlinear Schroedinger equation for the amplitude, while variations of the particle trajectories lead to a modified Vlasov equation, which includes the nonlinear reaction of the wave on the average trajectories. It is assumed that there are no resonant particles. These equations are coupled through the nonlinear frequency shift. It is found that the particle aspect of the plasma has a profound effect on the stability of the system, due to resonance of the wave envelope with particles moving at the group velocity. This effect, nonlinear Landau damping, is always destabilizing, leading to growth of modulations. In terms of the nonlinear Schroedinger equation, the effect changes the equation from a Hartree—Fock equation with a delta-function interaction to one with a nonmomentum-conserving, nonlocal interaction. In the limit of fairly small wavelength of the modulations, it is shown that the growth rate approaches that expected from plasma kinetic theory. (auth)

49635 PROPAGATION OF ELECTROMAGNETIC WAVES IN A WEAKLY IONIZED WARM MAGNETOPLASMA. Mishra, S. P.; Shukla, P. K.; Misra, K. D. (Banaras Hindu Univ., India). Aust. J. Phys.; 25: No. 3, 265-73(Jun 1972).

Modified wave equations for a weakly ionized warm magnetoplasma are obtained by linearizing Maxwell's equations with the help of the equation of state and the conservation equations for mass, momentum, and energy. The expressions derived for the refractive index for oblique and normal wave propagation from solutions of the equation of motion and from the modified wave equations are found to be equivalent. The results are used to study wave propagation in the ionosphere and the magnetosphere. (auth)

49636 SPONTANEOUS EXCITATION OF THE LONG-WAVE ION-CYCLOTRON AND ION-ACOUSTIC OSCILLATIONS IN FULLY IONIZED PLASMAS. Milic, B. (Inst. of Physics, Belgrade). Phys. Fluids; 15: No. 9, 1630-4(Sep 1972).

For model wavelengths longer than the electron mean free path, the damping coefficients of both longitudinal ion-cyclotron and ion-acoustic waves are close to zero. As in the collisionless plasma these coefficients may become negative provided that the electron drift velocity exceeds some threshold value, due to the normal Doppler effect. The threshold drift for both modes mentioned is evaluated, assuming that the plasma is fully ionized, i.e., using one-particle distribution function formalism and kinetic equations with Landau collision integrals. It is shown that the spontaneous excitation of the ion—cyclotron oscillations first sets in at the long wave limit, as the electron drift is gradually augmented. On the contrary, spontaneous excitation of ion-acoustic waves is first noted at short wavelengths. Conditions of existence of the long wave limits for both modes are discussed. (auth)

49637 ALFVEN WAVES IN INHOMOGENEOUS MAGNETIC FIELDS. Uberoi, C. (Indian Inst. of Science, Bangalore). Phys. Fluids; 15: No. 9, 1673-5(Sep 1972).

It was found that the rigorous and general treatment of electrostatic oscillations in a cold plasma of nonuniform density given by Barston can be extended to the case of Alfvén waves in an ideal fluid in the presence of a class of inhomogeneous magnetic fields. (auth)

49638 SYSTEMATIC DERIVATION OF THE WAVE KINETIC EQUATION FOR A HOMOGENEOUS PLASMA. Swift, Daniel W. (Univ. of Iowa, Iowa City). Phys. Fluids; 15: No. 9, 1675-7(Sep 1972).

The wave kinetic equation for waves in a homogeneous plasma is derived from Maxwell's equations and the linearized solution of the Vlasov equation. (auth)

49639 COMPARISON OF THE ELECTROMAGNETIC REFLECTION COEFFICIENTS FOR THE RANDOM PLASMA HALF-SPACE AND SLAB. Wasneski, Richard J. (Naval Weapons Lab., Dahlgren, Va.); Jarem, John. Phys. Fluids; 15: No. 9, 1677-9(Sep 1972).

The electromagnetic reflection coefficient for a random plasma half-space is compared to a slab computer experiment. It is demonstrated that the negative values of the change in reflection coefficient due to turbulence arise from the path length traveled by a multiple scattered wave component. (auth)

49640 RADIATIVE TRANSPORT ANALYSIS OF ELECTROMAGNETIC PROPAGATION IN ISOTROPIC PLASMA TURBULENCE. Feinstein, David L. (Cornell Aeronautical Lab., Inc., Buffalo); Butler, Frank E.; Piech, Kenneth R.; Leonard, Anthony. Phys. Fluids; 15: No. 9, 1641-51(Sep 1972).

The problem of electromagnetic wave propagation in a turbulent plasma is formulated in terms of the radiative transport equation. A singular eigenfunction solution is obtained for the case of isotropic plasma turbulence, and detailed numerical calculations are presented. The intensity distribution is studied as a function of the turbulent spectrum and relative strength of scattering attenuation to total attenuation. For a highly forward peaked scattering law characteristic of many physical situations it is found that the reflected backscatter intensity is relatively insensitive to the angle of incidence, except as grazing incidence is approached. The importance of multiple scatter is studied as a function of the properties of the medium. (auth)

49641 TURBULENT-LIKE SPECTRUM OF ION WAVES IN A BEAM–PLASMA SYSTEM. Amagishi, Y. (Shizuoka Univ., Japan). Phys. Rev. Lett.; 29: No. 7, 405-7(14 Aug 1972).

A quasi-one-dimensional spectrum of ion waves excited by a slow-electron beam is investigated experimentally. The power spectrum in a region of spatial wave decay is found to fall off with increasing frequency as $f^{-2\cdot3\pm0\cdot2}$. The result is compared with some nonlinear theories. (auth)

49642 NONEXISTENCE OF ION ACOUSTIC WAVES AND LANDAU DAMPING DRIVEN ELECTROSTATICALLY IN AN IDEAL Q MACHINE. Estabrook, Kent; Alexeff, Igor (Univ. of Tennessee, Knoxville). Contract AT(40-1)-4211. Phys. Rev. Lett.; 29: No. 9, 573-6(28 Aug 1972).

A computer was used to simulate ion acoustic wave generation by a grid. The self-consistent grid sheath and nonlinear effects were included. The experimentally observed wave propagation and Landau damping were reproduced quantitatively. Turning off the self-consistent electric field far from the grid left the "streaming" nature of the distribution function, the structure of the waves, and the magnitude of the damping essentially unchanged. (auth)

49643 INFLUENCE OF A CONSTANT ELECTRIC FIELD ON CYCLOTRON WAVES. Gurevich, L. E.; Shik, A. Ya. (Ioffe Inst. of Physics and Tech., Leningrad). Sov. Phys.-Solid State (Engl. Transl.); 14: No. 1, 58-61(Jul 1972).

Translated from Fiz. Tverd. Tela; 14: No. 1, 74-7(Jan 1972).

It is shown that a sufficiently strong electric field, applied perpendicularly to the magnetic field, significantly changes the spectrum of cyclotron waves and the shape of the curve for the Azbel'–Kaner cyclotron resonance. (auth)

49644 NUMERICAL SOLUTION OF DISPERSION EQUATION FOR A BI-MAXWELLIAN PLASMA. Kito, Masafumi (Electrotechnical Lab., Tokyo). Denshi Gijutsu Sogo Kenkyusho Kenkyu Hokoku; No. 723, 1-121(Dec 1971). (In Japanese).

If an initial distribution function is an entire function of a particle velocity, the inverse Laplace transform of the solutions makes a proper relation between k and ω. This relation represents a dispersion relation for the plasma. The dispersion relation takes a form of det $R_{ij} = 0$, where det R_{ij} is a determinant of R_{ij}, and R_{ij} $(i,j = 1, 2, 3)$ is an element of the determinant. Since equations $R_{11} = 0$ and $R_{22}R_{33} - R_{23}R_{32}$, respectively, give a dispersion equation for longitudinal and transverse plasma waves, the dispersion relation represents a more general equation of the plasma. The element R_{ij} is different, whether the wave propagation vector k is perpendicular to the external magnetic field or not. Both cases are treated when a thermal equilibrium state of the plasma is of a bi-Maxwell distribution function. (auth) (Japan)

49645 CORRELATION THEORY OF BACKSCATTERING FIELD IN A MAGNETOACTIVE PLASMA. Ivanov, V. A.; Tamoikin, V. V. (Scientific-Research Radiophysics Inst., Gorky, USSR). Izv. Vyssh. Ucheb. Zaved., Radiofiz.; 15: No. 2, 172-82(1972). (In Russian).

The backscattering of electromagnetic waves in an inhomogeneous magnetoactive plasma containing random inhomogeneities of the electron density is considered. The consideration is made under the assumption of narrow radiation patterns of transmitting and receiving antennas. The field space–time correlation and cross-correlation functions of the separate normal waves are calculated. The influence of the slope of the Earth's magnetic field on the statistical characteristics of the signal received is clarified. (auth)

49646 FLUCTUATIONS IN UNSTABLE RELATIVISTIC PLASMA. Akhiezer, I. A.; Chudnovskii, F. M. (Physical-Technical Inst., Kharkov). Ukr. Fiz. Zh. (Russ. Ed.); 17: No. 4, 618-22(Apr 1972). (In Russian).

General expressions for correlation functions are obtained, and the case of the isotropic velocity distribution of particles is investigated in detail. Fluctuations in relativistic plasma with the directed movement of the particles are considered. It is shown that if the plasma consists of hot electrons moving in relation to the cold ions, then, when the directed speed of the electrons approaches a definite critical value, the fluctuation level increases sharply (the phenomenon of critical fluctuations). (auth)

49647 DYNAMO-OPTICAL EFFECTS IN A PLASMA. Gavrilenko, V. G.; Lupanov, G. A.; Stepanov, N. S. (Gorky State Univ., USSR). Izv. Vyssh. Ucheb. Zaved., Radiofiz.; 15: No. 2, 183-90(1972). (In Russian).

The propagation of electromagnetic waves in an inhomogeneous moving cold electron plasma without the external magnetic field and collisions is considered. The motion is assumed stationary. It is shown that, in the case of a smooth change of the medium parameters, the beam trajectories in the zero geometrical optics approximation are determined by the density distribution, and the motion leads to the rotation of the wave polarization plane. An exact solution of equations, representing a superposition of two independent waves elliptically polarized with opposite senses of rotation, is obtained for a plane-stratified flow with a constant velocity gradient. The law of this wave refraction is found. The corresponding reflection and penetration coefficients are calculated for the case of the finite-layer thickness. (auth)

49648 TRANSMISSION AND REFLECTION OF AN ELECTROMAGNETIC WAVE INCIDENT NORMALLY ON A PLASMA HALF-SPACE. Mason, D. P. (Univ. of the Witwatersrand, Johannesburg). Physica; 60: No. 1, 41-62(Jul 1972).

The problem considered is that of reflection and transmission of a plane-polarized electromagnetic wave incident normally on a plasma half-space. The plasma is described by the Vlasov–Maxwell equations. A generalization of the eigenfunction technique used by Felderhof for specular reflection is given. An expansion theorem for the eigenfunctions, which does not depend on the assumption made for the boundary condition on the distribution function, is established. In particular, it is independent of the specular-reflection assumption. To illustrate its generality, it is shown how the specular- and the diffuse-reflection boundary conditions can both be dealt with, using this one expansion theorem. (auth)

49649 PRESSURE JUMP ACROSS NORMAL IONIZING SHOCK WAVES. Nitschke, P. H.; Brennan, M. H.; Phillips, M. G. R. (Flinders Univ. of South Australia, Bedford Park). Phys. Lett.; 40A: No. 5, 367-8(14 Aug 1972).

The pressure jump across normal ionizing shock waves in hydrogen was measured using piezoelectric probes. The observed pressure jumps exhibit substantial radial variations with average values higher than those predicted by theory. (auth)

PHYSICS (RADIATION AND SHIELDING)

Radiation Physics

Refer also to abstracts 48074, 49318, 49319, 49693, and 49772.

49650 (AD–739910) ADJOINT DIFFERENCE METHOD AND ITS APPLICATION TO DEEP-PENETRATION RADIATION TRANSPORT. Final Report, November 1, 1970–November 1, 1971. Hoffman, Thomas J.; Robinson, James C.; Stevens, Paul N. (Tennessee Univ., Knoxville. Dept. of Nuclear Engineering). Feb 1972. Contract DAAD05-71-C-0150. 84p. (NEUT–150-2; BRL-CR–63). NTIS.

The problem of determining the effect of interest in a geometrically complex object (vehicle) far removed from the radiation source is important in the area of radiation transport. The direct solution to this problem involves a deep-penetration, Monte Carlo calculation. Calculations of this type are always costly, and often impossible. To deal with this problem, the adjoint difference method was developed. This method decomposes the original problem into two independent calculations: a geometrically simple (one- or two-dimensional) deep-penetration calculation that is independent of the vehicle; and a localized, three-dimensional calculation that is independent of the radiation source. (auth) (NTIS)

49651 (ORNL-RSIC–33) REVIEW OF CALCULATIONS OF RADIATION TRANSPORT IN AIR: THEORY, TECHNIQUES, AND COMPUTER CODES. Proceedings of a Seminar, November 15–17, 1971. Trubey, D. K.; Comolander, H. E. (comps.) (Oak Ridge National Lab., Tenn.). May 1972. Contract W-7405-eng-26. 510p. (CONF-711125). Dep. NTIS.

Twenty-three papers are included, with a separate abstract being prepared for each of fourteen. The other nine appeared previously in NSA: see NSA 26: 13923, 16477, 21638, 21639, 24632, 26838, 26840, 29474, and 44464. (M.H.R.)

For abstracts of individual papers see: 49317–49322 and 49652–49659.

49652 (ORNL-RSIC–33, pp 109-16) UNFOLDING Ge(Li) GAMMA RAY SPECTRA PRODUCED IN LIQUID NITROGEN BY 14-MeV NEUTRONS. Reynolds, G. M.; Sperling, S. M. (Science Applications, Inc., La Jolla, Calif. (USA)). May 1972.

From Radiation Shielding Information Center seminar-workshop; Oak Ridge, Tenn. (15 Nov 1971).

An integral experiment previously performed measured secondary gamma spectra produced by a 14-MeV neutron source in liquid nitrogen. A significant flux of gamma rays in the 5 to 9 MeV region appeared when the continuum component of the integral spectrum was unfolded. The integral spectra in the region from 4.5 to 9 MeV was re-analyzed using superior unfolding techniques. The continuum component of unfolded data is shown, which supports the original hypothesis of Doppler-broadened gammas from the $^{14}N(n,\alpha)^{11}B$ reaction. (M.H.R.)

49653 (ORNL-RSIC–33, pp 117-55) COMPARISONS OF CALCULATIONS WITH INTEGRAL EXPERIMENTS WITH EMPHASIS ON SECONDARY GAMMA RAYS. Straker, E. A. (Science Applications, Inc., Huntsville, Ala. (USA)). May 1972.

From Radiation Shielding Information Center seminar-workshop; Oak Ridge, Tenn. (15 Nov 1971).

An evaluation of neutron and secondary gamma ray production cross sections for nitrogen was made by Young and Foster in 1970. The adequacy of these cross sections and the cross sections used by the author in calculating the transport of radiation in the atmosphere is evaluated by comparing calculations based on these two sets of cross sections with results of integral experiments. The sensitivity of the measurements to the transport of neutrons with energy less than 10 MeV illustrates that the integral experiments for secondary gamma rays are relatively insensitive to the gamma ray production cross sections for neutron energies less than 10 MeV. The newer evaluation of neutron cross sections is adequate for predicting the existing results of neutron experiments; however, based on the comparison of calculations with gamma ray results, there is no basis for choosing between the two sets of secondary gamma ray production cross sections. (auth)

49654 (ORNL-RSIC–33, pp 239-49) MAGI-SGD: A MONTE CARLO AIR-TRANSPORT CODE WITH A TIME-DEPENDENT SHOCK WAVE. Steinberg, H. A. (Mathematical Applications Group, Inc., White Plains, N. Y.). May 1972.

From Radiation Shielding Information Center seminar-workshop; Oak Ridge, Tenn. (15 Nov 1971).

MAGI-SGD is a Monte Carlo program for computing the gamma ray dose and dose rate due to interactions in air of neutrons from a nuclear weapon. The special feature of the code is that the time-dependent hydrodynamic effects, due to the blast, are incorporated directly into the air transport calculation. The effects of the air/ground interface and the inhomogeneous atmosphere are also taken into account. A preliminary series of calculations indicates that the blast effect must be considered for a completely realistic evaluation of weapon effects. (M.H.R.)

49655 (ORNL-RSIC–33, pp 251-77) NEW LOOK AT THE FISSION-PRODUCT GAMMA-RAY COMPONENT OF NUCLEAR WEAPON INITIAL RADIATION. Mooney, L. G.; French, R. L. (Radiation Research Associates, Inc., Fort Worth, Tex.). May 1972.

From Radiation Shielding Information Center seminar-workshop; Oak Ridge, Tenn. (15 Nov 1971).

A new model has been developed for predicting the fission-product gamma-ray component of the initial radiation exposure during the first minute following a nuclear detonation in air. The model incorporates Monte Carlo air transport data, fission-product source spectra, cloud rise approximations, air/ground interface effects, and hydrodynamic enhancement treatments from the work of a number of previous investigators. Fission-product gamma-ray doses calculated with the model, when combined with secondary gamma-ray doses based on Straker's air-over-ground neutron transport calculations, give results that generally agree with weapons test data within 25% for low-yield weapons and 50% for high-yield weapons. Calculations performed with the model show that the fission-product component of nuclear weapon initial radiation is often much more important than is generally indicated in the weapons effects literature. (auth)

49656 (ORNL-RSIC–33, pp 283-9) AIR TRANSPORT IN A DISTURBED ATMOSPHERE. Albert, Thomas E. (Martin-Marietta Corp., Orlando, Fla.). May 1972.

From Radiation Shielding Information Center seminar-workshop; Oak Ridge, Tenn. (15 Nov 1971).

The general effects of the transport of the prompt radiation from a nuclear detonation while in the vicinity of an atmospheric disturbance caused by a previous detonation are discussed. The neutron source considered was a typical thermonuclear source and the Oak Ridge DLC/14 air cross section set was used. For the purpose of a general discussion, an air density profile was taken to be one typical of a moderately low yield nuclear blast approximately 0.5 second after detonation. (M.H.R.)

49657 (ORNL-RSIC–33, pp 411-28) AIR TRANSPORT CALCULATIONS USING THE LASL–NWEF NEUTRON–GAMMA AIR FLUX TAPE AND THE NWEF COMPUTER PROGRAM CDR. Campbell, J. E. (Naval Weapons Evaluation Facility, Albuquerque, N. Mex.); Sandmeier, H. A. (Los Alamos Scientific Lab., N. Mex.). May 1972.

From Radiation Shielding Information Center seminar-workshop; Oak Ridge, Tenn. (15 Nov 1971).

The computer program CDR (Constant Dose Range) scales the results of transport calculations in uniform, sea-level air to produce ranges of constant dose from a point source of radiation in the atmosphere. CDR, in conjunction with the LASL-NWEF air flux tape, provides a flexible package for the calculation of dose ranges in the atmosphere from a point source consisting of neutrons, or gamma rays, or both. Although CDR was specifically designed to use the air flux tape, it can use the results of a coupled neutron–gamma, neutron–only, or gamma ray–only transport calculation. The calculations for the air flux tape were performed on the LASL CDC 6600 computer using an extended core version of DTF-IV. Complete transport calculations were performed in uniform, sea-level air for one source neutron in each of 30 energy groups and one source photon in each of 12 energy groups. (M.H.R.)

49658 (ORNL-RSIC–33, pp 429-50) INTRODUCTION TO SMAUG, AN ESTIMATOR OF THE NEUTRON AND GAMMA-RAY PROMPT DOSE ENVIRONMENT IN THE VICINITY OF AN ATMOSPHERIC NUCLEAR DETONATION. Murphy, Harry M. Jr. (Air Force Weapons Lab., Kirtland AFB, N. Mex.). May 1972.

From Radiation Shielding Information Center seminar-workshop; Oak Ridge, Tenn. (15 Nov 1971).

The computer code, SMAUG, its advantages, and options are described at length. Given a nuclear detonation specified in terms of yield, burst altitude, neutron source spectrum, and gamma source spectrum, and given a receiver point specified in terms of ground range and altitude, SMAUG computes the neutron and gamma particle fluence, energy fluence, mean energy, and energy spectrum as well as the absorbed dose in both tissue and silicon at the receiver point. (M.H.R.)

49659 (ORNL-RSIC-33, pp 451-502) MODELS OF RADIATION TRANSPORT IN AIR: THE ATR CODE. Harris, R. J. Jr.; Lonergan, J. A.; Huszar, L. (Science Applications, Inc., La Jolla, Calif. (USA)). May 1972.

From Radiation Shielding Information Center seminar-workshop; Oak Ridge, Tenn. (15 Nov 1971).

Research is described on the development of parametric models for efficiently calculating radiation transport in the atmosphere. The ATR computer code for neutrons and secondary gammas is discussed at length. It was designed as a user-oriented code to calculate a wide variety of radiation environment problems at all altitudes in the atmosphere. (M.H.R.)

49660 (RISO-M-1460) DOUBLE-P_1 CALCULATION OF GAMMA-RAY TRANSPORT IN SEMI-INFINITE MEDIA. Kirkegaard, P. (Danish Atomic Energy Commission, Risoe. Research Establishment). Apr 1972. 37p. Dep. NTIS (U. S. Sales Only).

A double-P_1 calculation method for γ-ray transport in semi-infinite and homogeneous media is outlined. The medium is adjacent to vacuum and contains γ sources of a spatially uniform, but arbitrary spectral distribution. Particular attention is paid to calculation of the surface flux. The one-dimensional energy and angular-dependent transport equation is solved by an adaption of Gerstl's method. A short description is given of the computer program GAMP 1. (auth)

49661 PECULIARITIES OF EXCITON MECHANISM OF FAST ELECTRON STOPPING IN CRYSTALS. Pundyk, A. V.; Glauberman, A. E. (Odessa State Univ.). Ukr. Fiz. Zh. (Russ. Ed.); 16: No. 9, 1494-1500(Sep 1971). (In Russian).

Analysis is made of the angular dispersion of fast electron energy loss function for exciton generation in nonmetallic crystals. The case of a strongly anisotropic crystal of laminated type is considered. With definite orientations of the electron beam, weakening is shown to take place in energy loss intensity. The case of "indirect" exciton generation and possible results for recombination luminescence are discussed. (auth)

49662 EMPIRICAL EQUATION FOR THE AVERAGE ENERGY-LOSS FRACTION OF BACKSCATTERED ELECTRONS. II. Tabata, Tatsuo; Ito, Rinsuke; Okabe, Shigeru (Radiation Center of Osaka Prefecture, Osaka). Jap. J. Appl. Phys.; 11: No. 8, 1220(Aug 1972).

Previously, an empirical equation was reported that expresses the average energy-loss fraction $\langle \Delta T \rangle / T_0$ of all the electrons scattered into the backward hemisphere as a function of incident energy T_0 for the primary electrons incident perpendicularly on the effectively semi-infinite target. Values of parameters in this equation were determined for cases of target atomic number Z = 13, 29, and 78-82. An attempt was made to express these parameters by simple functions of Z by utilizing additional experimental data that have become available recently. The resulting empirical equation for $\langle \Delta T \rangle / T_0$ as a function of T_0 and Z is presented. (M.H.R.)

49663 DISPERSION BEHAVIOR UNDER A CHANGE IN MEAN FREE PATH. Khisamutdinov, A. I. Zh. Vychisl. Mat. i Mat. Fiz.; 12: No. 1, 257-62(1972). (In Russian).

For solving a particle transport problem (neutrons, γ quanta) by the Monte Carlo method under nonmultiplying conditions, modifications are employed that are connected in some way with the path length. The dispersions of the modified method ($D\tilde{\xi}$) are compared with those of the unmodified method ($D\zeta$). Beyond some interval of parameter values which characterize the change in the mean free path, $D\tilde{\xi} > D\zeta$, and within the same interval it is possible that $D\tilde{\xi} < D\zeta$. An example is given that illustrates the use of $D\tilde{\xi}$ for solving problems in nuclear geophysics. (tr-auth)

49664 APPLICATION OF RADIOCHROMIC DYE FILM DOSIMETRY TO MEDIUM-Z ABSORBERS. Eisen, Harvey; Rosenstein, Marvin; Silverman, Joseph (National Bureau of Standards, Gaithersburg, Md. Univ. of Maryland, College Park). pp 77-80 of Record of the 11th Symposium on Electron, Ion, and Laser Beam Technology. /Thornley, R. F. M. (ed.). New York; Inst. of Electrical and Electronics Engineers, Inc. (1971).

From eleventh symposium on electron, ion, and laser beam technology; Boulder, Colo. (12 May 1971).

Radiochromic dye film dosimetry was used to measure depth-dose distributions produced by plane-parallel electron beams in absorbers ranging in atomic number from 13 to 50. Data were obtained for Al, Cu, and Sn absorbers for incident beam angles of 0, 30, and 60° to the surface normal. All work was done in a vacuum with 2-MeV electrons and in broad-beam geometrical configuration. The data are compared with computer calculations generated by means of the ETRAN program. (auth)

49665 ENERGY DEPOSITION PROFILES IN THERMOELASTIC MEDIA FROM A 45-kA, 3-MeV ELECTRON BEAM. Perry, F. C.; Buxton, L. D. (Sandia Labs., Albuquerque, N. Mex.). pp 81-8 of Record of the 11th Symposium on Electron, Ion, and Laser Beam Technology. /Thornley, R. F. M. (ed.). New York; Inst. of Electrical and Electronics Engineers, Inc. (1971).

From eleventh symposium on electron, ion, and laser beam technology; Boulder, Colo. (12 May 1971).

Information was obtained for the first time with a thermoelastic dosimetry technique in the most intense region of the REBA electron beam, i.e., in the magnetic pinch. The electron beam, generated from a Marx generator, Blumlein, and output tube, has the nominal characteristics: 3-MeV average energy, 45-kA current, and pulse duration of 70 ns FWHM. A Doppler-shift Mach-Zehnder interferometer was employed to measure the dynamic response of a solid (rear free surface velocity-time history) subjected to an intense burst of electrons. These measurements were then used in a thermoelastic calculation to obtain the electron energy deposition profile in the solid. Experiments and analysis provided energy deposition profiles for beam intensities up to approximately 120 cal/cm^2 in a brittle single crystal, x-cut quartz. A quartz specimen is, in principle, capable of providing information for electron-beam fluences that considerably exceed the present maximum fluence of REBA. Data were also analyzed for AISI 4340 steel hardened to RC-54, and energy-deposition profiles in the steel were obtained for fluences up to about 50 cal/cm^2. Comparisons of the quartz results in the magnetic-pinch region and in a portion downstream from the pinch have suggested that the electron angular distribution varies with axial position and contains electrons with larger angles of incidence in the pinch region. (auth)

49666 BREMSSTRAHLUNG FROM CYLINDRICAL BETA SOURCES. Harris, Dale W.; Silverman, Joseph (Univ. of Maryland, College Park). J. Appl. Phys.; 43: No. 9, 3855-62(Sep 1972).

Experimental techniques and equipment were developed for measuring absolute bremsstrahlung spectra from thick cylindrical sources of $^{147}Pm_2O_3$, $^{204}Tl_2O_3$, and $^{90}Sr-^{90}YTiO_3$. The total bremsstrahlung energy yield for each source was obtained from the photon spectra by the application of calculated corrections for photon absorption in the source, cladding, and air gap. The experimental results are compared with the thin-target theory of Bethe and Heitler, a modified thin-target theory that utilizes empirical correction factors proposed by Koch and Motz, and extended by Berger and Seltzer, and Wyard's thick-target approximation. The experimental results are in good agreement with modified thin-target theory, but suggest that the empirical correction factors are too large at energies below 0.2 MeV and too small at higher energies. Dose rates obtained experimentally for $^{147}Pm_2O_3$ and $^{90}Sr-^{90}YTiO_3$ are compared to those in Arnold's shielding handbook. The handbook results are greater than the experimental values especially for beta emitters with low end-point energies; this arises from the approximate methods used for his self-absorption corrections. (auth)

49667 DETERMINATION OF RADIATION YIELDS IN EXPERIMENTS WITH MIXED RADIATION. Briskman, B. A. (Inst. of Chemical Physics, Moscow). High Energy Chem. (USSR) (Engl. Transl.); 6: No. 1, 28-31(1972).

Translated from Khim. Vys. Energ.; 6: No. 1, 38-42(1972).

Errors involved in measuring radiation yields, G_n, for the neutron component of absorbed reactor radiation are determined, distinguishing two cases, namely: 1) the working material is a component part of the dosimetry system, and 2) G_n is obtained by recalculation of dosimetry data. Calculation has also been made of the error in determining the absorbed dose rate in one material from the known dose rate and composition in some other substance. Procedures for reducing these errors are suggested. (auth)

49668 ESTIMATION OF SCATTER DURING DIAGNOSTIC RADIOLOGICAL PROCEDURES USING A MODEL. Schoknecht, G. (Institut fuer Sozialmedizin und Epidemiologie des Bundesgesundheitsamtes, Berlin). Fortschr. Geb. Roentgenstr. Nuklearmed.; 116: No. 3, 415-19(Mar 1972). (In German).

The distribution of scatter from narrow beams of photons of varying energies was calculated by the Monte Carlo method. From this, scatter distribution can be calculated theoretically for various significant radiological models. For an estimate of radiation dose during diagnostic radiological procedures it is useful to relate scatter distribution to a constant primary beam dose rate. The results show that increasing kilovoltage results in a decrease of scatter in the vicinity of the primary beam. At a greater distance, however, an increase in the scatter can be recorded with increasing kilovoltage. In addition, the relationship between scatter distribution and field size was examined. (tr-auth)

49669 LOW-ENERGY COMPONENTS OF SCATTERED GAMMA RADIATION. 1. CALCULATION OF THE ENERGY SPECTRA OF TRANSMITTED GAMMA RADIATION BY MONTE CARLO METHOD. Minato, Susumu (Government Industrial Research Inst., Nagoya, Japan). Nagoya Kogyo Gijutsu Shikensho Hokoku; 21: No. 2-3, 55-61(Mar 1972). (In Japanese).

Transmission spectra of gamma rays scattered through a medium several times were calculated by Monte Carlo method. Dependences of low-energy components of the spectra on source energy, the thickness of a medium, the atomic number of the medium, boundary condition and source geometry were investigated. A characteristic spectral pattern which had a peak in a low-energy region was obtained. The intensity of the spectrum decreased slowly as the energy increased in the energy region above the peak. However, it showed rapid decrease in the lower-energy region. Although this pattern was barely changed by various conditions described above, the energy corresponding to the peak was strongly dependent on the atomic number of the medium. (auth) (Japan)

49670 SHELL WISE PHOTOELECTRIC CROSS-SECTIONS OF GAMMA RAYS AT 145 keV. Rao, K. Sivasankre; Rao, B. V. Tirumala; Rao, B. Mallikarjuna; Parthasaradhi, K. (Andhra Univ., Waltair, India). Curr. Sci. (India); 41: No. 13, 502(5 Jul 1972).

Results on higher-shell cross sections in medium- and high-Z elements (Ag, Sn, Ta, and Pb) using a previously reported method are presented. (M.H.R.)

49671 ACCURATE DETERMINATION OF CORRECTION FACTORS FOR β-RAY SELF-ABSORPTION IN GOLD FOILS. Hachiya, Yuuki; Hatakenaka, Haruo (Sumitomo Atomic Energy Industries, Ltd., Tokai, Japan). J. Nucl. Sci. Technol. (Tokyo); 9: No. 6, 321-9(Jun 1972).

A new method was developed for obtaining the β-ray self-absorption correction factor of a Au foil with uniformly distributed β-ray source. The method is essentially to average the β-ray self-absorption correction factor of Au-foil packs composed of nonactivated Au layers and an activated Au layer placed at the various depths. The β-ray self-absorption correction factors of the Au foil with thicknesses ranging 0.15–80 mg/cm^2 were measured within an experimental error of less than 0.5%. Between the thicknesses of 0 and 10 mg/cm^2, a sharp decrease was observed. In the range of thickness below 45 mg/cm^2 the present experimental results diverge from the currently used formula ($f_a = (1 - e^{-\mu t})/\mu t$), but are in good agreement with a semi-empirical expression ($f_a = (1/2 - E_3(\mu t)/\mu t$) formulated on the assumption of isotropic penetration of β rays. The escape probability of β rays emitted from a certain depth of Au foil was also measured as a function of source depth. By using this escape probability it is possible to obtain the β-ray self-absorption correction factors for any concave source distribution through the thickness of a foil, a situation commonly encountered especially in the foil irradiated with epithermal neutrons. (auth)

49672 RANGES IN TUNGSTEN OF ^{99}Mo AND ^{132}Te FRAGMENTS FROM THE THERMAL NEUTRON FISSION OF ^{235}U. Hontzeas, S.; Blok, H. (Univ. of Saskatchewan, Regina). Phys. Scr.; 4: No. 6, 229-34(1971).

The median ranges of ^{99}Mo, ^{132}Te were measured by collecting uncollimated fission fragments from the thermal neutron fission of a thin ^{235}U target in tungsten catchers. Depth distributions of these radioactive species were obtained by sequential sectioning of the tungsten catchers, radiochemical isolation of the fission fragments in each section and subsequent radioactive assay. The anodising and stripping technique of McCargo et al. for forming and removing uniform surface films of known thicknesses from tungsten was used in the sectioning. The median ranges obtained from these depth distributions were 10.03 ± 0.06, 8.60 ± 0.06 mg/cm^2 for ^{99}Mo, ^{132}Te, respectively. The median ranges of ^{99}Mo and ^{132}Te have not been measured before in tungsten. These measured ranges are both ~20% lower than values calculated by the theory of Lindhard, Scharff and Schiøtt. However, it is shown that a modification of the range–energy relation of Lindhard et al. results in calculated range values within ~3% of measured ranges in uranium, gold and tungsten. (auth) (Sweden)

49673 HIGH-ENERGY NUCLEON TISSUE DOSES (UP TO 30 GeV). Dmitrievskii, I. M.; Kabakov, Ya. I.; Potemkin, E. L.; Frolov, V. V. At. Energ. (USSR); 32: No. 6, 465-70(Jun 1972). (In Russian).

A simple method is presented for calculating depth-dose curves for high-energy neutrons and protons normally incident on the surface of a tissue-equivalent phantom having the form of a slab 30-cm thick and infinite in lateral extent. The distribution function of shower particles in a phantom was obtained by using the energy and angular distribution of such particles according to the Trilling formula. The transformation from the obtained distribution function of shower particles to the dose distribution was made by using mean characteristics of nuclear interactions such as mean multiplicity of secondary particles, mean excitation energy of residual nuclei, etc. Such an approach considerably reduces the volume of calculations and is justified by the fact that existing nuclear interaction theories and experiments give most reliable results precisely about averaged characteristics. Moreover, the dose concept also reflects averaged characteristics. Depth-dose distributions for protons and neutrons having energies from 0.4 to 30 GeV were obtained. The dose increases by a factor of about two when the energy increases from 3 to 30 GeV. The results obtained for nucleon energies up to 3 GeV are in reasonable agreement with the results of other authors. (6 figures, 19 references) (auth)

49674 INVARIANT IMBEDDING AND RADIATION DOSIMETRY: FINITE-ORDER SCATTERING AND TRANSMISSION FUNCTION. Bellman, R.; Ueno, S.; Vasudevan, R. (Univ. of Southern California, Los Angeles). Math. Biosci.; 14: No. 3-4, 235-54(Aug 1972).

The diffuse reflection and transmission of radiation by a finite target slab play an important role in radiation dosimetry. A method is presented of computing the scattering and transmission functions of radiation that has undergone a finite number $n (n \geq 1)$ of scatterings before emergence from the homogeneous, isotropically scattering slab. Employing the method of invariant imbedding, integro-differential recurrence formulas are arrived at for these functions. Because of the fact that these are linear relations, these functions may be computed readily in an iterative fashion corresponding to any desired number of scatterings. Furthermore, extending the above procedure, recurrence formulas are obtained for the cumulative scattering and transmission functions of radiation, which has undergone interactions once, twice, thrice, and so forth up to any order $n (n \geq 1)$ during the passage through the slab. These cumulative functions, as their order n increases indefinitely, tend to the Chandrasekhar's scattering and transmission functions for the standard transfer problem. In the appendix the extension of the Bellman–Krein formula for the resolvent kernel of a Fredholm integral equation to the case of any finite order n is discussed. (auth)

49675 MONTE CARLO SIMULATION FOR FAST ELECTRON AND PHOTON TRANSPORT IN THICK LAYERS OF MATTER. Sugiyama, Haruo (Electrotechnical Lab., Tokyo). Denshi Gijutsu Sogo Kenkyusho Kenkyu Hokoku; No. 724, 1-74(Feb 1972). (In Japanese).

A Monte Carlo program was developed for the calculation of fast electron and photon penetration in matter. Multiple scattering of electrons, straggling of electrons, energy loss by ionization and excitation, production of knockon electrons, and production of bremsstrahlung photons were considered. For photon penetration, the photoelectric effect, Compton effect, pair production, and annihilation radiation from positrons at rest or in flight were also considered. Some typical calculated results are energy spectra, backscattering coefficient for electrons, spatial distribution of energy dissipation, transmission coefficient and extrapolated ranges, and slowing-down spectra for perpendicularly incident electron beams. For photon beams, energy backscattering coefficient (energy albedo), electron energy spectra in water and aluminum, energy-loss distribution, and quotient of absorbed dose and kerma, and electron slowing-down spectra are reported. (auth) (Japan)

49676 GENERALIZED SEMIEMPIRICAL EQUATIONS FOR THE EXTRAPOLATED RANGE OF ELECTRONS. Tabata, T.; Ito, R.; Okabe, S. (Radiation Center of Osaka Prefecture, Sakai, Japan). Nucl. Instrum. Methods; 103: No. 1, 85-91(1972).

The extrapolated or practical range R_{ex} of monoenergetic electrons in the energy region 0.3 keV to 30 MeV for the absorbers of atomic number 6 to 92 has been found to be expressed by a single semi-empirical equation of the form $R_{ex} = \alpha_1[(1/\alpha_2)\ln(1 + \alpha_2\tau) - \alpha_3\tau/(1 + \alpha_4\tau\alpha_5)]$, where τ is the incident kinetic energy in units of the rest energy of the electron, and the parameters α_i ($i = 1, 2, \ldots, 5$) are given by simple functions of atomic number Z. Values of nine constants to express α_i have been determined by least-squares fit to a total of 232 experimental points reported in 18 references; the data used have been confined to those obtained from number-transmission measurement. The rms deviation of the equation from the experimental data is 4.5% for energies above 1 MeV and 8.4% for the entire energy region. Although the latter value is rather large, it is mainly due to large fluctuation of the experimental data for energies below 1 MeV. An approximate inverse relation which expresses τ as a function of R_{ex} is also given. (auth)

Radiation Protection Standards

49677 (ACRH–1000-329) SURVEY OF REGIONAL CALIBRATION FACILITIES FOR BIOMEDICAL RADIATION DOSIMETRY IN THE UNITED STATES. Lanzl, Lawrence H. (Argonne Cancer Research Hospital, Chicago, Ill. Chicago Univ., Ill. Dept. of Radiology). Dec 1971. Contract AT(11-1)-69. 10p. (CONF-711213–3). Dep. NTIS.

From Symposium on the use of isotopes and radiation in research on soil-plant relationships including applications in forestry; Vienna, Austria (13 Dec 1971).

Intercomparison measurements of exposure and absorbed dose in medical applications are covered. A distinction is made between intercomparison and intercalibration. The following topics are considered: organizational arrangement and implementation of intercomparisons or intercalibrations; types of instruments and techniques employed; and intercomparison of exposure and absorbed dose in generalized as well as specific geometries. (M.H.R.)

Radiation Source Calibration and Standardization

Refer also to abstracts 48237 and 48238.

Shielding Calculations and Theory

Refer also to abstracts 48888, 48901, 49988, and 49993.

49678 GAMMA RAY ATTENUATION IN BASEMENT CEILINGS. Reynolds, Roger Smith. Manhattan, Kan.; Kansas State Univ. (1971). 82p. University Microfilms Order No. 72-17,089.

Thesis.

Experiments have been performed which give further insight into the discrepancies between theoretically predicted and experimentally measured attenuation of scattered fallout radiation in basement ceilings, the so-called in-and-down scattering problem. Experiments were performed on a full-scale structure with basement ceiling mass thickness of 12 psf and zero psf at several solid-angle fractions. Additional experiments were performed for several ceiling mass thicknesses at a solid-angle fraction near unity. Generally, the experiments showed that previously published ceiling attenuation factors are inadequate for large solid angle fractions regardless of the overhead mass thickness. For small mass thicknesses and solid angle fractions below about 0.8 the agreement between experiment and previously published results is reasonable. It is clear that ceiling attenuation factors should demonstrate a solid angle fraction dependence as well as a mass thickness dependence. However, these experiments show that there is no reason to believe that in the limit as the solid angle fraction approaches unity, the ceiling attenuation factor should approach old formulations which had no solid angle fraction dependence. It has also been shown in this work that ceiling attenuation factors may be experimentally determined solely from finite field data. There is no need to estimate far-field contributions or skyshine contributions in the determination of ceiling attenuation factors. (Diss. Abstr. Int., B)

49679 DETERMINATION OF COMPOSITION OF ^{60}Co RADIATION SPECTRUM AFTER PASSAGE THROUGH A COVER OF CONCRETE ONE METER THICK. Szymczyk, Wislawa; Byrski, Edward; Polak, Bogumil (Inst. of Oncology, Krakow). Pol. Przegl. Radiol. Med. Nukl.; 36: No. 3, 395-9(1972). (In Polish).

The use of the matrix method for determination of the composition of the spectrum of dispersed radiation from a ^{60}Co source is described. (auth)

49680 VOPROSY FIZIKI ZASHCHITY REAKTOROV. SBORNIK STATEI. VYPUSK 5. (Reactor Shielding Physics. Collection of Articles. Issue 5). Broder, D. L. (ed.). Moscow; Atomizdat (1972). 276p.

This collection of 26 articles by various authors represents investigative work on problems in the physics of reactor shielding during 1968–1969. Studies of spatial, energy, and angular distributions of radiation in different homogeneous and heterogeneous shielding materials are analyzed. The contemporary state of the theory of, and calculation methods for, radiation shields for nuclear reactors are presented in detail. A number of articles focus attention on neutron spectra from reactors under various conditions, e.g., in water and iron of varied configurations, and the differential albedo of neutrons. (K.S.W.)

PHYSICS (SOLID-STATE)

Radiation Effects

Refer also to abstracts 48455, 48521, 49661, and 50022.

49681 (CONF-720707-7) RADIATION AND ANNEALING STUDIES ON OXYGEN-DOPED AND LITHIUM DIFFUSED GERMANIUM. Cleland, J. W. (Oak Ridge National Lab., Tenn.). Jul 1972. 23p. Dep. NTIS.

From Annual conference on nuclear and space radiation effects; Seattle, WA. (24 Jul 1972).

Hall-coefficient and resistivity measurements were used to determine the apparent carrier concentration and mobility of n-type Ge doped with specific impurities, or grown to contain oxygen, and then altered by annealing, ^{60}Co photon irradiation, or Li diffusion. Annealing at 350°C increased the donor concentration and decreased the mobility of oxygen-doped Ge as a consequence of oxygen clustering. Subsequent annealing at 500°C decreased the donor concentration and increased the mobility as a consequence of oxygen dissociation. Clustering and dissociation were repeated many times with no apparent alteration of total oxygen content. The apparent rate of introduction of lattice defects by ^{60}Co photons was essentially independent of oxygen concentration in Ge containing up to $\sim 10^{16}$ dissociated oxygen cm^{-3}. Formation of a primary defect state at $E_c - 0.2$ eV was observed for all concentrations. There was no evident interaction between the radiation-induced defects and oxygen after defect formation, but some evidence was observed of defect stabilization against annealing in oxygen-doped Ge. There also was no evident interaction between Li and normal donors or oxygen in Ge after Li diffusion, precipitation, and annealing (~400°C), but Li interacted with ''deep-level'' acceptor impurities (Ag, Au, or Cu) to form donors that were stable up to ≥500°C. (auth)

49682 (FRNC-TH-197) EFFECT OF Sb DOPING AND ELECTRON IRRADIATION ON THE SCATTERING OF PHONONS IN Ge AT LOW TEMPERATURES. Laurence, Guy (Paris Univ., Orsay (France)). 1969. 81p. (In French).

Thesis.

The thermal conductivity (K) was measured between 5 and 100°K for Sb concentrations between 8×10^{13} and 10^{18} cm^{-3}; at low temperatures K decreases with increasing levels of Sb doping. The electron—phonon scattering due to the Sb centers was estimated from the additional resistivity; the increase in resistivity with concentration is similar to that for impurity conduction. The effect of irradiating Ge(Sb) at 40°C with 4-MeV electrons on the thermal conductivity of the n/p transition region induced by electron bombardment was studied. K was measured between 5 and 80°K after each irradiation. With increasing flux, K increases, passes through a maximum, and then diminishes, attaining a value in the compensation region which is less than the preirradiation value. Hall effect measurements were also made on Ge. (France)

49683 (ORNL-4779, pp 1-10) SURFACE STUDIES, DIFFRACTION, AND CHANNELING. Apr 1972.

In Solid State Division annual progress report for period ending December 31, 1971.

CRYSTALS— dislocation loops in hexagonal and isotropic, displacement field and point defect interaction, (T)
IONS— channeling in silicon and tungsten, calculations of depth dependence of nuclear encounters in
SILICON— ion channeling in, calculations of depth dependence of nuclear encounters in
TUNGSTEN— ion channeling in, calculations of depth dependence of nuclear encounters in (D.L.C.)

49684 (ORNL-4779, pp 10-21) RADIATION DAMAGE. Apr 1972.

In Solid State Division annual progress report for period ending December 31, 1971.

ALUMINUM— ion bombardment damage in, depth distribution of 1- to 10-MeV aluminum, (T)
ALUMINUM IONS— effects on aluminum at 1 to 10 MeV, depth distribution of damage energy, (T)
BERYLLIUM— radiation effects on properties of, annealing of fast-neutron
COPPER— radioinduced defect pinning points in, density and temperature dependence of fast-neutron
ELECTRONS— effects on lithium fluoride, temperature dependence of color center production in
LITHIUM FLUORIDES— radioinduced defects in, temperature dependence of electron
NEUTRONS, FAST— effects on defect pinning points in copper —effects on properties of beryllium, annealing of
NEUTRONS, THERMAL— effects on platinum, annealing and temperature dependence of
PLATINUM— radiation damage, annealing and temperature dependence of thermal-neutron
SODIUM CHLORIDES— energy storage in electron-irradiated, at high temperatures (D.L.C.)

49685 (ORNL-4779, pp 54-69) ELECTRONIC STRUCTURE AND SPECTROSCOPY. Apr 1972.

In Solid State Division annual progress report for period ending December 31, 1971.

ALKALI METAL HALIDES— defects in crystals of, calculation of force constant changes and relaxation effects of point
GADOLINIUM ALLOYS— Gd- Sb, electron band structure calculations for GdSb
MAGNESIUM OXIDES— zero-phonon lines from anion divacancies in
SODIUM CHLORIDES— spectra of silver-doped, infrared and Raman vibrational, (E/T) (D.L.C.)

49686 (SC-DC-721172) DIVACANCY-LIKE ABSORPTION IN ION-BOMBARDED Ge. Stein, H. J. (Sandia Labs., Albuquerque, N. Mex.). 1972. 17p. (CONF-720713-1). Dep. NTIS.

From International conference on defects in semiconductors; Reading, England (19 Jul 1972).

A prominent optical absorption band at 2.40 μm was observed in Ge following 400-keV H^+, O^+, or B^+ ion bombardment at ~90°K. Subsequent heating to 150°K increases the 2.4-μm band, which then anneals out between 150 and 250°K with an experimental activation energy of 0.62 eV. Band-gap light speeds up the annealing and reduces the activation energy. Below 150°K, photons of ~0.75 eV induce a second band at 2.72 μm and decrease correspondingly the 2.4-μm band. Reheating to 150°K restores the 2.4-μm band. From correlations with defect characteristics in Si, and because the divacancy is a prominent defect in ion-bombarded Si, the 2.4-μm band is tentatively ascribed to the divacancy in Ge. (auth)

49687 (SC-DC-721318) RADIATION DAMAGE DURING ION IMPLANTATION. Vook, F. L. (Sandia Labs., Albuquerque, N. Mex.). 1972. 24p. (CONF-720713-2). Dep. NTIS.

From International conference on defects in semiconductors; Reading, England (19 Jul 1972).

Ion implantation provides a controlled method for studying high defect concentrations in crystalline semiconductors and the transition to the amorphous state. Experimental results of the crystalline-to-amorphous transition in silicon for many implantation parameters are correlated in terms of the energy deposited into atomic (nuclear) processes. At low implantation temperatures, the amorphous transition depends primarily on the properties of silicon rather than on those of the implanted ion, and the transition occurs for $\sim 6 \times 10^{23}$ eV cm^{-3} deposited into atomic (nuclear) processes. At implantation temperatures near and above room temperature, defect annealing and interactions with the high concentrations of implanted ions give an increasing dependence of the amorphous transition on the implanted ion type. If the energy into electronic processes creates an electron density exceeding threshold values, it is suggested that charge state-dependent intrinsic-defect annealing and interactions with the implanted ions can occur. Isotopic ion implantation and the incorporation of these ions into crystalline defects in silicon are an example of an important and successful new application of ion implantation to studies of the microscopic nature of defects in semiconductors. 52 references. (auth)

49688 COLOR CENTERS AND RADIATION-INDUCED DENSITY DECREASE OF SINGLE CRYSTALS OF LiF. Vladimirskii, Yu. B.; Nikitinskaya, T. I.; Peiterov, V. M. (Leningrad Polytechnic Inst.). Izv. Vyssh. Ucheb. Zaved., Fiz.; No. 12, 135-8 (1971). (In Russian).

The optical absorption of crystals of LiF in the F and M bands was investigated; the kinetics of buildup and energy of formation of electron centers in LiF were evaluated in the x-ray dose range from 0.14 to 12 and 150 Mrd. Radiation-induced decrease in the density of LiF samples was studied over the range 7.5 to 75 Mrd. (K.S.W.)

49689 RELATION OF COLOR-CENTER CONCENTRATIONS TO YIELD STRESSES IN γ-IRRADIATED CRYSTALS OF NaCl AND KCl. Kuz'menko, P. P.; Makara, V. A.; Novikov, N. N. (Kiev State Univ.). Ukr. Fiz. Zh. (Russ. Ed.); 16: No. 9, 1570-2(Sep 1971). (In Russian).

Changes in yield stress in crystals of NaCl and KCl were evaluated using rigid deformation machines while the crystals were subjected to 10^2 to 4×10^9 R of γ radiation. A study of dislocation immobility was also conducted, and the additional optical absorption spectra of these crystals was examined. The dependence on the radiation dose was a complex function, suggesting the formation of different types of defects corresponding to a change in stability characteristics of crystals at various stages of their irradiation. (tr-auth)

49690 EXTENDED CUTOFF MODEL FOR BLOCKING DIPS. Verondini, E. (Univ., Bologna). Phys. Lett.; 40A: No. 4, 341-2 (31 Jul 1972).

Some consequences are discussed of the assumption (suggested by Monte Carlo calculations) of a dependence of the cutoff distance on the emission angle of blocked particles. Results are given for Ge and 4.3-MeV protons. (auth)

49691 FORMATION AND ANNEALING OF DEFECTS IN GERMANIUM DURING BOMBARDMENT WITH KRYPTON IONS. Abroyan, I. A.; Kalugin, M. M.; Podsvirov, O. A. (Leningrad Polytechnic Inst.). Sov. Phys.-Solid State (Engl. Transl.); 14: No. 1, 203-4(Jul 1972).

Translated from Fiz. Tverd. Tela; 14: No. 1, 252-54(Jan 1972).

Germanium single crystals were bombarded by Kr ions of 2 to 20 μA/cm^2 density. The target temperature was deduced from its resistance. The ion-electron emission coefficient γ was measured and used to find the critical temperature T_c for transition to the disordered state. A plot of ln j vs $1/T_c$ was linear, and its slope gave the activation energy for annealing of the most stable defects, 1.5 ± 0.2 eV. The efficiency for defect formation was found to vary with angle, being lower when the ion beam was oriented along a close-packed direction. The energy dependence of the efficiency was determined along the ⟨110⟩ direction for energies from 3 to 20 keV. (D.L.C.)

49692 INFLUENCE OF CHANNELING ON THE SCINTILLATION EFFICIENCY OF A CsI:Tl SINGLE CRYSTAL. Kuleshov, E. A.; Stupak, V. A.; Shipatov, E. T. (Donets State Univ., USSR). Sov. Phys.-Solid State (Engl. Transl.)· 14: No. 1, 209-10(Jul 1972).

Translated from Fiz. Tverd. Tela; 14: No. 1, 258-60(Jan 1972).

An investigation was made of the dependence of the scintillation efficiency K of a CsI : Tl single crystal on the incident angle of a 5.49-MeV α-particle beam relative to the [111], [110], [100] axes and the {110}, {100} planes. K increased when the α particles traveled along channels; the increase was greatest for the most open direction, [111]. The absolute efficiency in this direction was 1.55×10^4 quanta/MeV. The angular dependence indicated that α particles are defected from axial channels into channels formed by crystallographic planes. (D.L.C.)

49693 "ABNORMAL" STOPPING POWER FOR LOW-VELOCITY ION CHANNELING. Ohtsuki, Y. H.; Kitagawa, M. (Waseda Univ., Tokyo). Phys. Lett.; 40A: No. 4, 313-4(31 Jul 1972).

The abnormal stopping power for heavy-ion channeling in the low-velocity region is calculated making use of Firsov's theory. Results are given for 60-MeV I ions in the Au (100) channel; they are in good agreement with Robinsons' expression. (auth)

49694 BEHAVIOR OF IRRADIATION DEFECTS IN GERMANIUM TUNNEL JUNCTIONS. Nemoto, Kuniharu (Nippon Electric Co. Ltd., Tokyo). Denki Kagaku; 40: No. 5, 376-9(May 1972). (In Japanese).

Variations in the impurity distribution of the tunnel junction were observed when the Esaki diode was heat-treated or operated in the forward current region beyond the valley point voltage after neutron irradiation. Complex vacancy—arsenic defects would appear from the interaction between radioinduced defects in the tunnel junctions and As impurity. The diffusion coefficient of As becomes greater in proportion to the concentration of irradiation defects. The experimental degradation coefficient I_p caused by the flow of current subsequent to irradiation agreed with the value obtained from the mechanism of electromigration to the tunnel junction with the diffusion coefficient of As in junction, temperature current density, etc. being taken into consideration. (auth) (Japan)

49695 OPTICAL STUDY OF ION CRYSTALS BY USING PULSED ELECTRON BEAM. Ueta, M.; Hirai, M.; Kondo, Y.; Yoshinara, T. (Tohoku Univ., Sendai). Kakuriken Kenkyu Hokoku; 4: No. 1, 72-6(Sep 1971). (In Japanese).

Creation and annihilation of lattice defects produced transiently in alkali halide crystals by irradiation with a 30-MeV pulsed electron beam, especially color centers and their triplet states, were measured by an optical method. Results for KBr and KI are reported. F absorption band of KBr crystals at 4°K was seen at about 600 nm, and decay time constants were ~20 and 70 μsec. The decay time constants decreased with rising temperature of the crystals, and its temperature dependence gives an activation energy ΔE of 0.045 eV for F—H recombination. Absorption bands at 775 and 900 nm were observed for KBr and KI, respectively, at about 4°K. The respective decay time of these bands was 100 and 3 μsec. The same temperature dependence as that of proper luminescence suggested that the absorption bands were due to triplet excitons. Impurity mixing (Ag$^+$ 0.1 mole %) reduced the F-center production in KCl crystals to $^1/_3$ of that for pure KCl crystals. Effect of Cu$^+$ was negligibly small. A preliminary experiment on energy transfer between the exciton and the F center in KCl was performed, but no quantitative result was obtained. (Japan)

49696 INDICATION OF ^{73}Ge MOESSBAUER EFFECT IN 50-MeV ELECTRON-IRRADIATED GERMANIUM. Matsui, Keiji (Tohoku Univ., Sendai). Kakuriken Kenkyu Hokoku; 4: No. 1, 80-2(Sep 1971).

Moessbauer spectra found in 50-MeV electron-irradiated germanium crystals are reported in relation to the 13.5-keV $^5/_2{}^+-^9/_2{}^+$ E2 transition of ^{73}Ge. The electron beam intensity was roughly estimated to be 4×10^{17} electrons/cm^2 hr, and the irradiation was performed for 7 hr. Specimens were accidentally heated up to several hundred degrees centigrade before the irradiation. The specimens were doped with ^{57}Co, which emits 14.4-keV gamma rays for velocity scale calibration. A decay curve of the induced activity shows that β^- decay of the ^{37}Ga remains dominant during a few tens of hours after the irradiation. Five Moessbauer spectra were obtained at 4.5-hr intervals from 21 hours after the irradiation. The maximum dip of apparent absorption varies from 0.7 to 0.3%. The spectra are too complicated to compare with calculation, but it appears that some radiation-induced defects made the spectra complex. A discrete spectrum represented by $|Q/Q_0|$ = 0.25 and $|eQ_0q/2|$ = 0.7 mm/sec was observed at 295°K in an n-type crystal free from primary damage. Observed line broadening (~0.3 mm/sec) suggests a jump of 0.4-eV germanium interstitials in 4 μsec after β-recoil of the ^{73}Ga. (Japan)

49697 50-MeV ELECTRON IRRADIATION OF GERMANIUM DOPED WITH ^{57}Co. II. Matsui, K. (Tohoku Univ., Sendai); Ohkawa, A. Kakuriken Kenkyu Hokoku; 4: No. 1, 77-9(Sep 1971).

Pair formation observed in irradiated germanium doped with Co-57 is reported. Specimens experienced accidental heating up to several hundred degrees centigrade before the irradiation. The irradiation was carried out for 7 hours with 50-MeV electron beam of 4×10^{17} electrons/cm^2 hr. Moessbauer spectra obtained at 295°K for 2 to 16 hr after the irradiation indicated 3 pairs of quadrupole doublets with isomer shift of +0.06 cm/sec. Large quadrupole splitting $\Delta_2 = 0.48$ and $\Delta_3 = 0.67$ cm/sec indicates the formation of ion pairs, just as observed in neutron-irradiated silicon. Giant splitting formalism for Fe^{3+}, which is paired with negatively charged defect or impurity in such a way that low-spin configuration results, suggests that Δ_2 and Δ_3 correspond respectively to (113) and (023) axial field configuration, in which (lmn) denotes $(d_0)^l(d_{\pm1})^m(d_{\pm2})^n$ with $l + m + n = 5$. It may be added that line intensity ratio implies ⟨100⟩ ion pairs both for Δ_2 and Δ_3. (Japan)

49698 ELASTIC INTERACTION BETWEEN POINT DEFECTS AND A DISK INHOMOGENEITY IN AN HEXAGONAL CRYSTAL. Masumura, R. A. (Naval Research Lab., Washington, D. C.); Grupen, W. B.; Sines, G. H. Cryst. Lattice Defects; 3: No. 2, 103-7(May 1972).

The elastic interaction energy between point defects and a disk inhomogeneity lying in the basal plane of hexagonally symmetric crystal was calculated from linear continuum mechanics. The disk inhomogeneity can be used as a model of a dislocation loop or a second-phase inclusion. From the elastic interaction energy, the motion of a point defect in the presence of a disk inhomogeneity can be predicted. These results indicate that the growth of a dislocation loop and shape evolution of a precipitate are dependent upon the volume changes produced by the point defect and the inhomogeneity in the elastic medium. (auth)

49699 CONCENTRATION PROFILES AND ENHANCED DIFFUSION IN ION-IMPLANTED SILICON STUDIED BY RADIOACTIVATION ANALYSIS. Gamo, Kenji (Osaka Univ.); Iwaki, Masaya; Masuda, Kohzoh; (and others). pp 103-10 of Record of the 11th Symposium on Electron, Ion, and Laser Beam Technology. /Thornley, R. F. M. (ed.). New York; Inst. of Electrical and Electronics Engineers, Inc. (1971).

From eleventh symposium on electron, ion, and laser beam technology; Boulder, Colo. (12 May 1971).

Concentration profiles of ion-implanted antimony and indium are measured by means of radioactivation analysis. Indium is implanted in single-crystal silicon and amorphous silicon produced by nitrogen implantation and the effect of crystalline phase on impurity distribution is investigated. The effect of enhanced diffusion is also investigated. Concentration profiles of room-temperature ion-implanted indium are in agreement with those predicted by LSS theory. Antimony and indium show enhanced diffusion during heat treatment after room-temperature implantation but in the case of indium enhanced diffusion occurs only in the lower concentration region than about 1×10^{19} In/cm^3. The diffusion coefficient and profiles are obtained by solving the diffusion equation. (auth)

49700 OBSERVATION OF A VOID SUPERLATTICE CONTAINING A DISLOCATION IN NEUTRON IRRADIATED Mo–0.5 PERCENT Ti. Sikka, V. K.; Moteff, J. (Univ. of Cincinnati). Cryst. Lattice Defects; 3: No. 2, 113-14(May 1972).

Transmission electron microscopy was used to illustrate the presence of a "dislocation" in the void superlattice formed in this dilute molybdenum alloy which was irradiated with neutrons at about 0.3 $T_{m'}$, where T_m is the absolute melting temperature of the base metal. (auth)

49701 COMPUTER EVALUATION OF PRIMARY-DEPOSITED ENERGY PROFILES IN ION-IMPLANTED SILICON UNDER CHANNELING CONDITIONS. Desalvo, A.; Rosa, R.; Zignani, F. (CNR, Bologna). J. Appl. Phys.; 43: No. 9, 3755-60(Sep 1972).

Primary deposited energy profiles produced by 40-keV P ions channeled along the [110] direction in silicon are computed. The model takes into account impact-parameter-dependent electronic energy loss and dechanneling mechanisms, such as thermal vibrations, electronic scattering, and a surface oxide layer. The deposited energy is converted to damage by using Kinchin and Pease's model and distributed along the range of primary recoils or dechanneled ions in two ways: either uniformly or localized at the average damage depth, evaluated using Winterbon, Sigmund, and Sanders's theory. The model is tested for the random case with experiments available. When no dechanneling mechanism is present, radiation damage is reduced by a factor of 10 compared to the random case. Thermal vibrations increase damage almost uniformly along all the channeled path, while the oxide layer increases the damage mostly at the surface. The combined effect of these mechanisms gives a reduction of radiation damage of only a factor of ~2 compared to the random case. The results show also that damage is mostly concentrated at the surface about 85% in the first 2000 Å compared to a maximum penetration of 7600 Å. (auth)

49702 SIMULATION OF TRANSIENT SPACE-CHARGE FLOW IN A SEMICONDUCTOR UNDER IONIZING IRRADIATION. Norris, C. B. (Sandia Labs., Albuquerque, N. Mex.). J. Appl. Phys.; 43: No. 9, 3769-73(Sep 1972).

Some promising initial results in the development of a numerical procedure for the direct simulation of transient space–charge flow in a semiconductor are described. A computer code is described that employs a simulation technique to predict the internal dynamics and terminal response of a reverse-biased p-n junction subjected to high-level transient ionizing irradiation in a circuit environment. By comparing the predictions of the simulation code and a mathematically based code in regard to a specific problem, it is shown that the simulation technique can yield accurate solutions for analytically intractable problems in a realistic amount of computing time. The adaptability of the simulation technique to certain studies not feasible with the mathematically based codes is pointed out. (auth)

49703 COLORATION INDUCED IN MgO BY MeV ^{20}Ne$^+$ BOMBARDMENT. Evans, Bruce D.; Comas, James, Malmberg, Philip R. (Naval Research Lab., Washington, D. C.). Phys. Rev., B; 6: No. 6, 2453-62(15 Sep 1972).

The coloration produced near room temperature in MgO by 1.0- to 4.8-MeV ^{20}Ne$^+$ bombardment was investigated. Energetic Ne$^+$ ions incident upon crystalline MgO induce point defects on the anion sublattice primarily through atomic collisions. An electron(s) trapped in the anion vacancy forms an F-type center producing a characteristic, intense optical-absorption band near 5 eV. This point-defect lattice damage is restricted primarily to a thin layer of material approximately 1 to 2 μ thick located 2 to 4 μ beneath the bombarded surface. Average F-type-center volume concentrations in this thin layer range from 4×10^{18} to 5×10^{19} cm^{-3} resulting from a Ne$^+$ dose range of 10^{13} to 3×10^6 ions/cm^{-2}. F-type-center production is relatively inefficient; it is estimated that 5 keV are expended per center produced, in the low-dose range, assuming centers are created only by atomic collision processes. The peak F-type-center volume concentration saturates near 10^{20} cm^{-3} resulting from a dose of 10^{16} ions/cm^2 at 3-MeV energy. This concentration level is followed by a decrease upon subsequent bombardment. A similar saturation effect is observed for a 574-nm absorption band. A quadratic dependence between the growth of the intensity of the F-type center and that of the 574-nm band suggests the latter is associated with a divacancy. Volume-concentration saturation levels for both bands are independent of many impurities commonly present in this material. Isochronal annealing results demonstrate that both bands have annealed out at 600°C. Comparison is made with previously reported fast-neutron irradiations and the present work. Point defects on the cation sublattice, such as the V$^-$ center, were sought but determined not to be present in sufficient concentration to be detected by the presence of the well-known 2.3-eV optical-absorption band. (auth)

49704 ANNEALING STUDY OF ION-IMPLANTED SILICON BY PHOTOELECTROMAGNETIC METHOD. Inada, Taroh; Ohnuki, Yasuhide; Nishimura, Hidetaroh (Hosei Univ., Tokyo). Appl. Phys. Lett.; 21: No. 4, 137-9(15 Aug 1972).

The photoelectromagnetic effect (PEM effect) on indium-implanted silicon was examined as a function of ion dose in the range 10^{14} to 10^{15} ions/cm^2 and annealing up to 800°C. Results indicated that the measurements of the PEM voltage can be used to detect changes in lattice ordering in ion-implanted silicon caused by the annealing treatment. From combining PEM voltage measurements with electron diffraction examinations, it was found that crystal reordering in In-implanted silicon by post annealing occurred from an inward part of the host crystal rather than from the ion-implanted surface. (auth)

49705 LATERAL SPREAD BORON IONS IMPLANTED IN SILICON. Akasaka, Youichi (Mitsubishi Electric Corp., Amagasaki, Japan); Horie, Kazuo; Kawazu, Satoru. Appl. Phys. Lett.; 21: No. 4, 128-9(15 Aug 1972).

The lateral spread of implanted ions is measured in boron-implanted silicon by junction delineation. The maximum lateral spread of a p-type region from a mask edge is about half the junction depth. Typical values are 0.4 to 0.6 μ in n-type substrates of 0.1 Ω cm at an implantation energy in the range 75 to 250 keV with the dose level of 1×10^{15}/cm^2, or at 150 keV with the dose in the range $1 \times 10^{14} - 5 \times 10^{15}$/cm^2. These experimental values are well interpreted by the theory in which the lateral spread is expressed as a complementary error function with the standard deviation calculated by the LSS theory. (auth)

49706 RADIATION STABILITY OF SEMICONDUCTORS HAVING STOICHIOMETRIC VACANCIES. Gal'chinetskii, L. P.; Koshkin, V. M.; Kumakov, V. M.; (and others) Sov. Phys.-Solid State (Eng. Transl.); 14: No. 2, 554-6(Aug 1972).

Translated from Fiz. Tverd. Tela- 14: No. 2, 646-8(Feb 1972).

It is suggested that $A_2^{III}B_3^{VI}$ semiconductors, with a large density of neutral stoichiometric vacancies, would be more resistant to radiation. To test this suggestion, In_2Te_3 and Ga_2Te_3 were irradiated with γ rays, fast electrons, fast neutrons, and mixed reactor radiation. Resistivity, thermal emf, carrier density, and carrier mobility were measured before and after irradiation. The results indicate that these two compounds are indeed stable compared with other semiconductors, such as CdTe and ZnTe. The In_2Te_3 dark conductivity in the reactor remained intrinsic during the irradiation. The decrease of the thermal emf of In_2Te_3 indicates disordering in the cation sublattice. (D.L.C.)

49707 AVERAGE ENERGY TO FORM ELECTRON-HOLE PAIRS IN GaP DIODES WITH ALPHA PARTICLES. Kobayashi, T. (Tokyo Shibaura Electric Co. Ltd.). Appl. Phys. Lett.; 21: No. 4, 150-2(15 Aug 1972).

The energy required to form an electron–hole pair in gallium phosphide was measured using GaP p–n junction diodes made from high-purity-level GaP materials. The values of ϵ_{GaP} for several GaP diodes for alpha particles ranged from 6.35 to 6.75 eV, with an average value of 6.54 ± 0.13 eV at 300°K. This value is smaller than that obtained by Goldstein and is very close to the value of 6.56 eV calculated from the experimental relationship $\epsilon = 2.596\ E_g + 0.714$ (eV), which was derived previously from the experimental values of ε for Ge, Si, GaAs, and CdTe. (auth)

49708 RADIATION DAMAGE IN $KMgF_3$:$KMnF_3$. Vehse, W. E. (Oak Ridge National Lab., Tenn.); Sibley, W. A. Phys. Rev., B; 6: No. 6, 2443-53(15 Sep 1972).

Optical absorption, bleaching, and annealing studies of mixed crystals of $KMgF_3$: $KMnF_3$ irradiated at 80°K with 2.0-MeV electrons are reported. It was found that the presence of Mn suppresses the F-center production mechanism in $KMgF_3$. At concentrations of Mn greater than 1.4 at.%, the absorption spectrum is dominated by a set of five bands originating from a single type of defect. A possible model for this defect involving an F center trapped between adjacent Mn ions is discussed. Limited studies of the $KMgF_3$: $KZnF_3$ system were made for purposes of comparison. (auth)

49709 EFFECT OF IMPURITY ATOMS ON RECOVERY OF NEUTRON-IRRADIATED COPPER AT 78°K. Papathanassopoulos, K.; Andronikos, P. (Democritus Nuclear Research Center, Athens). Phys. Status Solidi (a); 12: No. 1, K59-63(16 Jul 1972).

Electric-resistivity observations were made on the recovery of Cu (alloyed with 0.5 to 1.5 at. % Au or 0.1 to 0.75 at. % Ni) after neutron irradiation at 78°K. The effects of Ni and Au on the annealing behavior of Cu are different. For Ni, the stage II recovery is similar to that of pure Cu, the plateau region (9 to 200°C) is suppressed, and the stage V peaks are higher. For Au, the substage heights II_1 (180°K) and II_2 (160°K) increase and decrease respectively with Au content, and there is no plateau between stage III and cluster annealing at 200°C. It is concluded that Ni atoms trap mobile interstitials and that the absence of the plateau in Au-doped Cu is due to migration of vacancy—solute atom pairs. (D.L.C.)

49710 THERMAL ANNEALING OF X-RAY-INDUCED DEFECTS IN Sr-DOPED KCl CRYSTALS. Katz, I.; Chenfoux, B.; Kristianpoller, N. (Tel-Aviv Univ., Israel). Phys. Status Solidi (a); 12: No. 1, 307-15(16 Jul 1972).

Thermal annealing of point defects induced by x-irradiation at room temperature (RT) in Sr-doped KCl crystals is investigated by absorption and luminescence methods. A correlation between the luminescent glow peaks and the annealing steps of the various color centers is shown. The divalent impurity causes a shift of all glow peaks to lower temperatures. An additional glow peak appears in these samples after optical bleaching with F light. Thermal activation energies of the glow peaks in the doped crystals are considerably lower than those of the analogous peaks in pure KCl. The spectral decomposition of the thermoluminescence shows also an influence of the divalent impurity on the emission bands. The main blue emission band, which appears in pure KCl at 440 nm, shifts in the Sr-doped samples to 475 nm. This wavelength shift fits the energy difference between the V_2 absorption bands in pure and doped crystals. The half-widths of these emission bands equal approximately the half-widths of the V_2 bands. The same 475-nm band appears at all main glow peaks above RT, indicating that the same main recombination process is connected with the thermal destruction of the various color centers. (auth)

49711 DISPLACEMENT OF ARSENIC ATOMS IN SILICON CRYSTAL DURING IRRADIATION. Fujimoto, F. (Tokyo Univ.); Komaki, K.; Ishii, M.; Nakayama, H.; Hisatake, K. Phys. Status Solidi (a); 12: No. 1, K7-8(16 Jul 1972).

A 2-MeV He^+ beam was backscattered at 84, 281, or 454°K from a $\langle 111 \rangle$ Si crystal containing 0.16 at. % As produced by the Czochralski method. The minimum yield was found to increase rapidly with He^+ dose, unlike that for pure Si which remained almost constant with dose, but extrapolation to zero gave a value close to that for pure Si bombarded by either He^+ ions or 1.5-MeV protons. The results indicate that almost all the As atoms are located on lattice sites, and that they are rapidly displaced by ion irradiation. (D.L.C.)

49712 ELECTRICAL AND STRUCTURE SENSITIVE MEASUREMENTS ON ION IMPLANTED GaAs. Bicknell, R. (Plessey Co. Ltd., Towcester, Eng.); Hemment, P. L. F.; Bell, E. C.; Tansey, J. E. Phys. Status Solidi (a); 12: No. 1, K9-12(16 Jul 1972).

Radiation damage was observed in GaAs single crystals implanted with 100-keV Ar and 150-keV Te ions by transmission electron microscopy. For doses of 10^{12} to $10^{13}/cm^2$ at room temperature, many small defects were produced, while the higher doses produced only noncrystalline material. Ion implantations at higher temperatures were also studied, and Rutherford backscattering and electrical measurements were made; results show that implantation at 180°C allows recrystallization of the damage layer. (D.L.C.)

49713 LOW-TEMPERATURE RECOVERY OF MAGNETIC AFTER-EFFECT AND ELECTRICAL RESISTIVITY OF ELECTRON-IRRADIATED NICKEL. Lampert, G.; Schaefer, H. E. (Max-Planck-Institut fuer Metallforschung, Stuttgart. Univ., Stuttgart). Phys. Status Solidi (b); 52: No. 2, 475-84(1 Aug 1972).

The recovery of high-purity nickel electron-irradiated at 27°K was observed by simultaneous measurement of the electrical resistivity and the magnetic after-effect (MAE). A strong MAE observed at about 55°K anneals out in the substages I_D and I_E simultaneously with the electrical resistivity. In both stages I_D and I_E the same value of the activation energy of recovery $E^M = (0.155 \pm 0.02)$ eV was found from both types of measurement. Models describing the recovery in stages I_D and I_E in nickel by the annealing of a single type of defect configuration are strongly supported. (auth)

49714 STRESS-INDUCED ORDERING OF STAGE I DEFECTS IN MOLYBDENUM. Okuda, S.; Mizubayashi, H. (Japan Atomic Energy Research Inst., Tokai). Phys. Status Solidi (b); 52: No. 2, K85-7(1 Aug 1972).

Mo single-crystal plates with $\langle 100 \rangle$ axis were irradiated by neutrons at <10°K, and afterwards the internal friction and dynamic modulus were measured during warmup. Two relaxation peaks were observed at 11.5 and 39°K; they disappeared after warming up to 30 and 50°K, respectively, which coincide with the first two recovery substages of stage I for the electrical resistivity. The peak heights were only one tenth as high for the stress axis parallel to $\langle 111 \rangle$. The results suggest that both interstitials in the two types of close pairs that anneal in these two substages in Mo have a maximum strain field along $\langle 110 \rangle$ and make a stress-induced ordering without recombination. (D.L.C.)

49715 F-CENTRES OF TWO TYPES IN BaFCl CRYSTALS. Nicklaus, E.; Fischer, F. (Univ., Muenster, Ger.). Phys. Status Solidi (b); 52: No. 2, 453-60(1 Aug 1972).

F centers in x-irradiated and additively colored tetragonal BaFCl single crystals were studied. An F-center at a fluorine site absorbs light polarized parallel to the crystallographic c-axis in a band at 438 nm and light polarized perpendicular to c in a band at 550 nm. A chlorine F-center has a band at 532 nm ($E \parallel c$) and a double band at 440 nm ($E \perp c$). This dichroism arises from the tetragonal surroundings of the F centers. The splitting of the double bands is probably due to a dynamic Jahn—Teller effect. In an x-irradiated crystal, there is a partial transformation of fluorine into chlorine F centers. In additively colored BaFCl, predominantly fluorine-type F centers are formed above 300°C in thermal equilibrium. (auth)

49716 ANNEALING CHARACTERISTICS OF PHOSPHORUS IMPLANTED SILICON. 1. Bicknell, R. W. (Plessey Co. Ltd., Caswell, Eng.). Phil. Mag.; 26: No. 2, 273-86(Aug 1972).

Silicon implanted with 3×10^{14} 20-keV phosphorus ions/cm^2 was isochronally annealed at temperatures ranging from 600 to 1250°K. Sheet resistivity measurements of the specimens were taken after each anneal, together with corresponding transmission electron micrographs. The increase in conductivity is explained in terms of a first-order thermal reaction with an activation energy of 0.77 eV. The reaction rate for noncrystalline silicon produced by ion beam damage is shown to be about 40 times faster than for crystalline silicon, and the reaction occurs at temperatures below 900°K. The recrystallized silicon became epitaxial with the substrate over the temperature range 800 to 1100°K and was accompanied by loss of conductivity by the specimen. This process was identified as a second-order thermal reaction with an activation energy of 1.59 eV. Both reactions are discussed in terms of vacancy mechanisms. A study of the crystal defects in the recrystallized silicon revealed them to be either faulted or prismatic loops of approximately 500-Å diameter. (auth)

49717 DISLOCATION VOID INTERACTION. Willis, J. R.; Hayns, M. R.; Bullough, R. (Atomic Energy Research Establishment, Harwell, Eng.). Proc. Roy. Soc. (London), Ser. A; 329: No. 1576, 121-36(18 Jul 1972).

An exact solution for the induced field when a straight screw dislocation is adjacent to a spherical inhomogeneity is presented. This solution is used to calculate the interaction energy and force between the dislocation and the inhomogeneity. Specific results are given when the inhomogeneity is a spherical cavity (a void). The induced dilatation field is also obtained and used to discuss the resulting drift of interstitials into the void; the significance of this induced drift as a saturation mechanism in the growth of voids in irradiated materials is emphasized. (auth)

Physical Properties

Refer also to abstracts 47737, 48311, 48439, 49329, 49683, 49685, and 49788.

49718 (COO—3150—2) ELECTRICAL AND THERMAL TRANSPORT PROPERTIES OF TUNGSTEN AND THE RF SIZE EFFECT IN POTASSIUM. Wagner, David Kendall (Cornell Univ., Ithaca, N. Y. Materials Science Center). Nov 1971. Contract AT(11-1)-3150. 102p. Dep. NTIS.

Thesis.

Low-temperature measurements were made of ρ and WT (ρ is the electrical resistivity and W is the thermal resistivity) in high-purity tungsten single crystals in the absence of a magnetic field. The temperature dependence of ρ and WT was found to be predominantly quadratic, in agreement with observations in other transition metals. It is reasonable to attribute this behavior to electron—electron scattering. The validity of Matthiessen's rule for impurity and boundary scattering was investigated to determine whether the contributions of electron—electron scattering, ρ_e and W_eT, can be meaningfully separated from the total resistivities ρ and WT. In those samples in which boundary scattering contributes least to the total resistivities, Matthiessen's rule was approximately obeyed for the electrical resistivity, while deviations were observed for the thermal resistivity. For these samples, the measured values of ρ_e and W_eT yielded Lorenz numbers for electron—electron scattering, $L_e = \rho_e/W_eT$, that range from 0.2×10^{-8} to 0.4×10^{-8} WΩ/K^2. Measurements were also made in a strong magnetic field. Measurements of the high-field transverse electrical and thermal conductivities, σ_{xx} and κ_{xx}, of a high-purity tungsten single crystal are presented for the temperature range 1.5 to 6°K. The magnetic field dependences of the conductivities conform excellently to the predictions of high-field semiclassical magnetoresistance theory, provided that thermal conduction by the lattice was taken into account. The results showed that the lattice thermal conductivity is proportional to T^2, as expected for a pure metal in which the phonons are scattered principally by the conduction electrons. The temperature dependence of the high-field electrical conductivity σ_{xx}, and the corresponding electronic contribution $(\kappa_e)_{xx}$ to the thermal conductivity κ_{xx} were also measured. Theoretical expressions for these quantities are derived from semi-classical magnetoresistance theory, allowing estimates to be made of the temperature dependence associated with possible low-temperature scattering mechanisms. Difficulties in interpreting the previous zero-field measurements in terms of electron–electron or electron–phonon scattering are discussed. Longitudinal magnetoresistance is also discussed. Next, it was found that several interesting predictions regarding the role of electron–phonon scattering in the magnetoresistance of potassium can be made on the basis of semi-classical theory. Finally, an assessment was made of the prospect of using the rf size effect to detect anisotropies in the relaxation time in potassium. (auth)

49719 (CSIRO-Trans-10917) MAGNETO-CRYSTALLINE ANISOTROPY IN TERBIUM, DYSPROSIUM, AND HOLMIUM. Feron, M. Jacques-Louis. Translated by J. Rhemrev (Commonwealth Scientific and Industrial Research Organization, Australia), from Compt. Rend., Ser. B.; 269: No. 14, 611-14(1969). 4p. Dep. NTIS (U. S. Sales Only).

An abstract of this paper, prepared from the original language, appeared as NSA 24: 19976. (Australia)

49720 (LBL-425, pp 167-90) SOLID STATE PHYSICS. Apr 1972.

In Inorganic Materials Research Division annual report, 1971.

Progress is summarized in the following fields: theoretical solid-state physics, magnetic properties of solids, far infrared properties of solids, superconductivity, experimental solid-state physics and quantum electronics, and solid-state spin resonance and coherent laser pulse studies. 56 references to the publication of the research results as journal articles, reports, or conference papers are included. (D.L.C.)

49721 (N-72-21727) PHOTOEMISSION AND REFLECTANCE STUDIES OF THE ELECTRONIC STRUCTURE OF MOLYBDENUM. Kress, K. A.; Lapeyre, G. J. (Montana State Univ., Bozeman. Dept. of Physics). Dec 1971. 7p. (NASA-CR-126041). NTIS.

Photoemission and optical measurements were used to study the electronic structure of the 4d metal molybdenum. The photoemission data were found to be consistent with the nondirect model with one possible exception. Because of the essentially nondirect character of the photoemission data, an optical density of states (ODS) graph was constructed. The results are compared with band calculation of molybdenum's 5d counterpart, tungsten, and its 3d counterpart, chromium. (auth) (STAR)

49722 (ORNL-4779) SOLID STATE DIVISION ANNUAL PROGRESS REPORT FOR PERIOD ENDING DECEMBER 31, 1971. (Oak Ridge National Lab., Tenn.). Apr 1972. Contract W-7405-eng-26. 131p. Dep. NTIS.

Separate abstracts have been prepared for each of the 8 sections: surface studies, diffraction, and channeling; radiation damage; low-temperature properties; lattice dynamics; magnetic properties; electronic structure and spectroscopy; research materials; and experimental equipment and new techniques. Material in the sections that has been or will be published was not indexed. (D.L.C.)

For abstracts of individual sections see: 47968, 49237, 49683–49685, and 49723–49725.

49723 (ORNL-4779, pp 27-36) LATTICE DYNAMICS. Apr 1972.

In Solid State Division annual progress report for period ending December 31, 1971.

CALCIUM TUNGSTATES—phonon dispersion relations of
COBALT—phonon dispersion curves of hcp
MANGANESE FLUORIDES—phonon dispersion curves of MnF_2
MOLYBDENUM SULFIDES—phonon dispersion curves of hexagonal MoS_2
NIOBIUM SELENIDES—phonon dispersion curves of $NbSe_2$
SUPERCONDUCTORS—acoustical plasmon effects in transition-metal, (T)
TITANIUM—phonon dispersion curves of hcp
TRANSITION METALS—acoustical plasmon effects in superconducting, (T)
URANIUM CARBIDES—phonon dispersion curves
ZIRCONIUM CARBIDES—phonon dispersion curves of ZrC_x (D.L.C.)

49724 (ORNL-4779, pp 37-53) MAGNETIC PROPERTIES. Apr 1972.

In Solid State Division annual progress report for period ending December 31, 1971.

ERBIUM—spin-wave scattering intensity, (T)
ERBIUM ALLOYS—Er-base–Th, magnetic structure of hcp, neutron-diffraction study of effects of composition on
GALLIUM ALLOYS—Ga–Ni-base, magnetic moment distribution around iron impurity in Ni_3Ga
GOLD ALLOYS—Au-base–Fe, magnetic form factor and moment distribution in $FeAu_3$
HOLMIUM ALLOYS—Ho-base–Th, magnetic structure of hcp, neutron-diffraction study of effects of composition on
IRON—magnetic moment distribution around, in Ni_3Ga
IRON ALLOYS—Fe–Ni, magnetic form factors and moment distributions in FeNi and $FeNi_3$
—Fe-base–Si, magnetic disorder scattering of neutrons from, temperature dependence of
—Fe-base–Ti, magnetic disorder scattering of neutrons from, temperature dependence of
IRON CARBONATES—magnon–phonon dispersion relations and coupling
NEUTRON-DIFFRACTION ANALYSIS—studies of magnetic materials
NEUTRONS—scattering in magnetic materials, studies
NICKEL—magnetic scattering of neutrons by, (E/T)
THULIUM ALLOYS—Bi–Tm, crystal-field splitting in TmBi
THULIUM NITRIDES—crystal-field splitting in
TRANSITION METALS—neutron inelastic scattering intensity, (T)
YTTRIUM ALLOYS—Tb–Y-base, spin-wave dispersion curve of (D.L.C.)

49725 (ORNL-4779, pp 69-83) RESEARCH MATERIALS. Apr 1972.

In Solid State Division annual progress report for period ending December 31, 1971.

FERRATES—growth of large single crystals of
GERMANIUM—growth and characterization of large crystals of, for detectors
NIOBIUM ALLOYS—growth of single crystals of
RHENIUM—growth, purification, and tensile testing of single crystals of
STRONTIUM OXIDES—growth of large single crystals of pure and undoped (D.L.C.)

49726 WORK FUNCTION OF FACES (111) AND (110) FOR AN ALLOY OF TUNGSTEN WITH Os (1 PERCENT). Smirnova, N. B.; Shuppe, G. N.; Babushkin, O. L. (Tashkent State Univ.). Izv. Vyssh. Ucheb. Zaved., Fiz.; No. 12, 138-40(1971). (In Russian).

Work functions of the faces (111) and (110) of a crystal of a solid solution of Os (1 wt%) in W were measured over the temperature range 1,600 to 2,400°K. The temperature dependence of the work function for three faces of the alloy is discussed. In general, the values of the work function exceeded that of pure W. (K.S.W.)

49727 BEHAVIOR OF Li ATOMS ON THE FACES OF SINGLE CRYSTALS OF REFRACTORY METALS WITH BODY-CENTERED-CUBIC LATTICES. Zhanabergenov, K. Zh. (Kzyl-Ordinskii State Inst., USSR). Izv. Vyssh. Ucheb. Zaved., Fiz.; No. 12, 146-8 (1971). (In Russian).

The adsorption of alkali metals on the crystalline faces of metals such as W, Mo, Ta, and Nb as positive ions is discussed in terms of theoretical models. Experimental results in connection with the behavior of Li atoms on densely packed faces (110) of W and Ta crystals, and on "loose" faces (111) of W and Mo crystals are explained and related to the corresponding work functions. (K.S.W.)

49728 INVESTIGATION OF CRYSTAL STRUCTURE AND PECULIARITIES OF INTERATOMIC INTERACTION COMPONENT IN HIGHEST CARBIDE OF VANADIUM. Arbuzov, M. P.; Khaenko, B. V. (Inst. of Problems of Material Studies, Kiev). Ukr. Fiz. Zh. (Russ. Ed.); 16: No. 9, 1421-8(Sep 1971). (In Russian).

The x ray diffraction spectrum of reflections of the highest vanadium carbide, composition of VC_x, was investigated. The structure factor of the primary reflection (222) was found to have a lower value as compared with that calculated from the data for neutral atoms. The effect found shows that the ion interaction due to positively charged vanadium and negatively charged carbon must be one of the bond components in the highest vanadium carbide. Results of approximate calculation of the ionic compound phenomenological theory are in good agreement with the obtained data and evidence in favor of a conclusion on a primary ionic character of component interaction in this compound. (auth)

49729 NEUTRON-DIFFRACTION INVESTIGATION OF THE ATOMIC STRUCTURES OF INORGANIC MATERIALS. Yamzin, I. I.; Loshmanov, A. A. (Inst. of Crystallography, Moscow). Inorg. Mater. (USSR) (Engl. Transl.); 8: No. 1, 1-20(Jan 1972).

Translated from Izv. Akad. Nauk SSSR, Neorg. Mater.; 8: No. 1, 1-25(Jan 1972).

After a comparison of x-ray diffraction and neutron diffraction processes, a survey is presented of the use of neutron diffraction to determine the positions of H in H-containing compounds, light atoms in the presence of heavy atoms, and atoms with nearly equal atomic numbers and to study atomic displacements in ferroelectric transitions and ordering processes. (16 figures and 244 references) (D.L.C.)

49730 DAMPING RATE OF PLASMA WAVES IN CONDENSED MATTER. Elson, J. M.; Ritchie, R. H. (Oak Ridge National Lab., Tenn.). Surface Sci.; 30: No. 1, 178-84(Mar 1972).

An analytical expression is given for the damping rate of a long-wavelength plasma wave in terms of the optical constants of the medium which supports the wave. This expression is a generalization of that given in the literature for a free electron gas. The expression is derived by two different methods. (auth)

49731 NONMETAL–METAL TRANSITION IN $Eu_{1-x}Gd_xO$. Samokhvalov, A. A.; Gizhevskii, B. A.; Simonova, M. I.; Solin, N. I. (Inst. of Metal Physics, Sverdlovsk, USSR). Sov. Phys.-Solid State (Engl. Transl.); 14: No. 1, 230-1(Jul 1972).

Translated from Fiz. Tverd. Tela; 14: No. 1, 279-81(Jan 1972).

The nonmetal–metal transition in $Eu_{1-x}Gd_xO$ was studied using the electric conductivity, activation energy of electrical conduction, Curie temperature, and crystal lattice parameter as a function of x. At 293°K, the electric conductivity increased with x from 10^{-8} Ω^{-1} cm^{-1} for pure EuO, undergoing a sudden jump to 10^3 Ω^{-1} cm^{-1} at $x \sim 0.015$. The activation energy also decreased from 0.62 eV to zero, and the Curie temperature increased almost twofold at $x \simeq 0.015$. Two possible mechanisms are suggested. It is pointed out that this transition with x is observed only in the paramagnetic region. (D.L.C.)

49732 INVERSE SCALING OF THE LOW-TEMPERATURE-SPECIFIC-HEAT PARAMETERS γ AND Θ_D IN TRANSITION-METAL BINARY ALLOYS AND ITS DEPENDENCE ON PHASE STABILITY. Collings, E. W. (Columbus Labs., Ohio); Ho, J. C. Phys. Lett.; 40A: No. 4, 337-8(31 Jul 1972).

In low-temperature-calorimetric studies of transition-metal-binary alloys in the average group number or electron/atom ratio (z) range $4 < z < 7$, an inverse scaling noted in the γ and Θ_D (versus z) profiles can be rationalized in terms of the bcc binary alloy low-temperature structural phase stability. (auth)

49733 MAGNETIC SUSCEPTIBILITY AND ELECTRICAL RESISTIVITY OF $Ce_xY_{1-x}Al_2$. Purwins, H.-G.; Donze, P.; Susz, C. P.; Treyvaud, A. (Univ., Geneva). Phys. Lett.; 40A: No. 3, 217-18(17 Jul 1972).

The magnetic susceptibility and electrical resistivity were measured for $Ce_xY_{1-x}Al_2$ ($x = 0$, 0.05, 0.15, and 0.25) between 4.2 and 300°K. $\chi 3kT$ vanishes at low temperature. A minimum in resistivity is found at 60°K ($x = 0.15$) and 68°K ($x = 0.25$). (auth)

49734 EFFECT OF HYDROSTATIC PRESSURE ON THE PHONON SPECTRUM OF Pb–In ALLOYS USING ELECTRON TUNNELING. Hansen, H. H.; Pompi, R. L.; Wu, T. M. (State Univ. of New York, Binghamton). Phys. Lett.; 40A: No. 3, 201-2(17 Jul 1972).

The effect of hydrostatic pressure on the phonon spectrum of Pb–In alloys was studied. A shift to higher frequencies of the transverse, longitudinal, and impurity band peaks is observed, as well as a reduction in amplitude. (auth)

49735 INFLUENCE OF A HIGH-CONDUCTING BUBBLE IN VO_2 SWITCHING DEVICES. Mattheck, C. (Zentralinstitut fuer Festkoerperphysik und Werkstofforschung, Jena, Ger.). Phys. Status Solidi (a); 11: No. 2, K117-21(16 Jun 1972).

The switching behavior of a VO_2 cylinder with weak heat transport parallel to the axis and perfect cooling at the boundaries is studied theoretically. A high-conducting bubble arises and changes the temperature distribution. Equations are derived for the resistance and the I–V characteristic. The correlation between the current and the bubble shape shows that it is not necessary for the bubble to reach the electrodes for the switching to occur. (D.L.C.)

49736 MAGNETIC PROPERTIES OF SOME URANIUM COMPOUNDS OF AlB_2 TYPE. Misiuk, A.; Mulak, J.; Czopnik, A.; Trzebiatowski, W. (Inst. for Low Temperature and Structure Research, Wroclaw). Bull. Acad. Pol. Sci., Ser. Sci. Chim.; 20: No. 4, 337-41(1972).

The magnetic properties of UGa_2, UHg_2, and $USi_{1.67}$ were investigated over a wide temperature range. UGa_2 exhibits a ferromagnetic transition at 133°K, UHg_2 is probably antiferromagnetic with $T_N \approx 70$°K, whereas $USi_{1.67}$ does not indicate any magnetic transition. The magnetic properties of the investigated compounds are interpreted in terms of the crystal field model assuming $^3H_4$ term as a ground term of uranium. The crystal-field Hamiltonian of the AlB_2 type of structure was determined. (auth)

49737 ION-BACKSCATTERING ANALYSIS OF TUNGSTEN FILMS ON HEAVILY DOPED SiGe. Borders, J. A.; Sweet, J. N. (Sandia Labs., Albuquerque, N. Mex.). J. Appl. Phys.; 43: No. 9, 3803-8(Sep 1972).

The technique of ion backscattering was used to obtain information on the reactions taking place at the interface between a sputtered tungsten film and a heavily doped silicon–germanium alloy substrate. Significant differences were observed for n-type and p-type SiGe substrates. In both cases, silicon was observed to migrate into the tungsten at temperatures above 650°C and form a layer of atomic composition, WSi_2. There was little or no diffusion of silicon beyond the WSi_2 layer for the samples on n-type substrates, but on p-type SiGe, silicon diffused through the WSi_2 layer to the surface of the tungsten film. Tungsten films on single-crystal silicon showed small amounts of tungsten–silicon diffusion and little or no WSi_2 formation for anneals at and below 700°C. Samples with n-type SiGe substrates exhibited little or no tungsten–germanium diffusion, whereas samples on p-type substrates annealed to 675°C or higher showed significant migration of tungsten and/or germanium. The oxidation of the sputtered tungsten films was also investigated by ion backscattering. A 1200-Å-thick W film was completely converted to tungsten oxide (atomic composition WO_3) by annealing at 650°C, which inhibited WSi_2 formation. In addition, the growth of WO_3 on a thick W film was observed as a function of time. (auth)

49738 DETERMINATION OF THE DEFECT NATURE OF MoO_3 FILMS USING DIELECTRIC-RELAXATION CURRENTS. Nadkarni, G. S.; Simmons, J. G. (Univ. of Toronto). J. Appl. Phys.; 43: No. 9, 3650-6(Sep 1972).

A new technique, based on stimulated dielectric-relaxation currents (DRC), was successfully used to analyze the defect properties of $Al/MoO_3/Al$ systems. The particular aspect of the DRC technique used consists of cooling the system to low temperatures with a voltage applied to the electrodes and then raising the sample temperature at a uniform rate with the electrodes short-circuited. Pronounced structure is observed in the current–temperature characteristics, which may be related directly to the donor (or trap) density and the donor (or trap) distribution. The measurements obtained from the $Al/MoO_3/Al$ samples confirmed the existence of Schottky barriers at the interfaces and revealed the existence of a donor band in the MoO_3, which is centered about an energy 0.27 eV below the bottom of the conduction band. The half-width of the donor band is about 0.07 eV, and its density is approximately 1.5×10^{18} cm^{-3}. These results are in excellent agreement with those obtained from previous ac and dc measurements. It was also confirmed that an electrode-limited to bulk-limited transition occurs at about 0.6 V. The DRC technique is compared to the thermally stimulated current (TSC) technique, and it is concluded that the DRC method is the superior of the two, at least as far as thin films are concerned. Finally, the effect of Schottky barriers on conduction processes in thin films in general is discussed and it is shown that if they are present but overlooked, the interpretation of the data is invalid. (auth)

49739 AC ELECTRICAL PROPERTIES AND I–V CHARACTERISTICS OF MoO_3 FILM UNDER DC BIAS. Nadkarni, G. S.; Simmons, J. G. (Univ. of Toronto). J. Appl. Phys.; 43: No. 9, 3741-7(Sep 1972).

The ac electrical properties and the I–V Δ characteristics of $Au/MoO_3/Au$ thin-film sandwiches were measured under dc voltage bias. The capacitance of the samples is a strong function of the temperature and dc voltage bias. It increases as much as a factor of 20 for a 2900-Å-thick sample as the temperature is increased; this variation is reduced with increasing voltage bias. At 325°K the capacitance is a strong function of the dc voltage bias, decreasing from its zero-bias value by about 50% at $V = 1.5$ V. The voltage dependence of the capacitance decreases with decreasing temperature, and at $T = 77$°K it is essentially voltage independent. The conductance is also observed to be strongly dependent on temperature and dc voltage bias. For $V \lesssim 0.6$ V, it initially increases strongly with increasing temperature and reaches a maximum value at about 310°K. With further increase in temperature, it decreases to a minimum value and then increases monotonically. For $V \gtrsim 0.6$ V, the conductance increases monotonically with increasing temperature. The I–V characteristics under dc bias are essentially thickness independent for $V \lesssim 0.6$ V and thickness dependent for $V \gtrsim 0.6$ V. All the results are interpreted in terms of a self-consistent model that incorporates Schottky barriers at the two metal–insulator interfaces and a conduction process that exhibits an electrode-limited to bulk-limited transition occurring at V ≅ 0.6 V. (auth)

49740 HYBRIDIZED NONDEGENERATE 6d AND 5f VIRTUAL-BOUND-STATES MODEL FOR ACTINIDES METALS. Jullien, R.; Galleani d'Agliano, E.; Coqblin, B. (Laboratoire de Physique des Solides, Orsay, France). Phys. Rev., B; 6: No. 6, 2139-55 (15 Sep 1972).

A simple model taking into account two hybridized and nondegenerate 6d and 5f virtual bound states is presented here for describing the properties of pure actinide metals. The model, which describes the d–f hybridization by a simple mixing one-body Hamiltonian, is treated in the usual Hartree–Fock self-consistent scheme of Friedel–Anderson. The model can be made consistent with previous band calculations and with specific-heat measurements giving a large density of states at the Fermi level. It can then account for the absence of localized magnetism for the strongly d–f hybridized uranium, neptunium, and plutonium metals and for the occurrence of magnetism only in the middle of the series for curium and berkelium. (auth)

49741 RENORMALIZED-FREE-ATOM MODEL AND THE ELECTRON MOMENTUM DISTRIBUTION IN VANADIUM. Berggren, K.-F. (Univ. of Linkoeping, Sweden). Phys. Rev., B; 6: No. 6, 2156-61(15 Sep 1972).

Recent measurements of the Compton profile of polycrystalline vanadium are interpreted by means of a renormalized-free-atom model. The electronic configuration is varied, and it is found that the configuration in vanadium must be close to $3d^4 4s^1$ in atomic notations, in agreement with earlier experience. (auth)

49742 FREQUENCIES AND WIDTHS OF PHONONS IN DILUTE Cr–W ALLOYS. Kesharwani, K. M.; Agrawal, Bal K. (Univ. of Allahabad, India). Phys. Rev., B; 6: No. 6, 2178-92(15 Sep 1972).

A detailed study of the effects of force-constant changes on the frequencies and widths of phonons in random dilute alloys was made. A nearest-neighbor perturbation model including the changes in the mass and the changes in the central and noncentral force constants was employed. The theoretical results are compared with the inelastic neutron scattering experiments recently performed on Cr–W alloys containing different impurity concentrations (0.3, 0.8, 1.6, and 3.0 at.% W). The change in phonon frequency on account of the expansion of the crystal lattice on alloying is considered to explain the experimental results. Although an overall good agreement between the low-concentration theory and the experiments was observed at four different concentrations of tungsten atoms in chromium, there exist some discrepancies in certain frequency regions. (auth)

49743 NUCLEAR QUADRUPOLE RESONANCE AND MAGNETIC RELAXATION IN (LaGd)Al_2. MacLaughlin, D. E.; Daughtery, M. (Univ. of California, Riverside). Phys. Rev., B; 6: No. 6, 2502-6(15 Sep 1972).

Nuclear-quadrupole-resonance and relaxation measurements were made at low temperatures in the dilute (LaGd)Al_2 system at zero and low applied magnetic fields. The results complement those of McHenry, Silbernagel, and Wernick at high fields and are consistent with the onset of magnetic order in the Gd random-spin system. (auth)

49744 ENERGY BANDS IN BORON NITRIDE AND GRAPHITE. Zupan, J. (Univ., Ljubljana, Yugoslavia). Phys. Rev., B; 6: No. 6, 2477-82(15 Sep 1972).

The tight-binding approximation was applied for calculation of the band structure of planar hexagonal crystal layers of graphite and boron nitride. The theoretical width of the valence band of 15.9 eV in graphite and the distance between the centers of π and σ band of 5.3 eV as obtained in the present calculation are in good agreement with Chalkin's experimental work yielding 15 and 5 eV, respectively. For boron nitride, the width of the energy gap and the width of the valence band were calculated to be 4.9 and 6.8 eV, respectively. (auth)

49745 MAGNETIC PROPERTIES OF PRASEODYMIUM IN MAGNETIC FIELDS DETERMINED FROM THE NUCLEAR HEAT CAPACITY AND APPLIED TO NUCLEAR COOLING. Gregers-Hansen, P. E.; Krusius, M.; Pickett, G. R. (Helsinki Univ. of Tech., Otaniemi, Finland). Phys. Rev. Lett.; 29: No. 7, 420-23 (14 Aug 1972).

The nuclear heat capacity of praseodymium in fields from 0 to 18.6 kOe was measured from 16 to 300 mK. In zero field, the metal was found to be ordered with average magnetic moments of 0.62 and 0.05 μ_B on the two inequivalent lattice sites. Above 10 kOe, the Van Vleck behavior dominates and an induced moment appears on both sites. The corresponding induced hyperfine field was employed for nuclear cooling. (auth)

49746 MAGNETIC STRUCTURE OF $HoZn_2$. Debray, D.; Sougi, M. (CEN de Saclay, Gif-sur-Yvette, France). J. Chem. Phys.; 57: No. 5, 2156-9(1 Sep 1972).

Neutron powder diffraction measurements reveal that $HoZn_2$, having the body-centered orthorhombic crystal structure ($CeCu_2$-type), becomes an antiferromagnet below the Néel temperature of 13.5°K. The moment alignment is represented by the composite of two sinusoidal transverse waves both polarized in the b axis direction and propagating along the c axis but with the phase difference of 60.7 ± 1.2°. The propagation wavelength and amplitude at 4.2°K are, respectively, 2.27 in units of c and 9.4 ± 0.1 Bohr magnetons. Below 4°K, there are indications of the onset of another magnetic transition. (auth)

49747 ELECTRON SPECTRUM AND PHYSICAL PROPERTIES OF THE DODECABORIDES. Goryachev, Yu. M.; Odintsov, V. V.; Paderno, Yu. B. (Inst. of Problems of Materials, Kiev). Metallofizika; No. 37, 29-36(1971). (In Russian).

A number of physical characteristics of metal dodecaborides RB_{12} were investigated: electrical resistance, thermal emf, microhardness, thermal expansion coefficient, Hall constant, and thermal conductivity. R is Y, Tb, Dy, Ho, Er, Tm, Yb, Lu, or Zr. Several regularities in their properties were noted, and such regularities were correlated with data calculated from their electron spectra. (tr-auth)

49748 PROPERTIES OF OXYGEN DEPLETED CERAMIC $Pb(Zr_{0.65}, Ti_{0.35}(O_3$ + 1 WT. PERCENT Nb_2O_5 SURFACE LAYERS. Miller, D. W.; Glower, D. D. (Ohio State Univ., Columbus). Ferroelectrics; 3: 295-303(1972).

The properties of oxygen-depleted ceramic $Pb(Zr_{0.65}, Ti_{0.35})O_3$ + 1 wt % Nb_2O_5 surface layers were studied using the Hall effect, conductivity versus temperature measurements, and capacitance and dissipation factor versus frequency measurements. Surface layers having thicknesses (measured via an electron microscope) between 25 and 250 microns were grown by rapidly heating a cleaned and etched ceramic PZT pellet to 500°C in a quartz chamber filled with oxygen free argon gas. In this manner the virgin PZT is transformed from a highly compensated p-type semiconductor having a conductivity of less than 10^{-11} $(\text{ohm-cm})^{-1}$ to an n-type semiconductor having conductivities of 10^{-5} to 10^{-8} $(\text{ohm-cm})^{-1}$ by the introduction of oxygen defect states which act as electron donors. The conductivity versus temperature measurements for several samples indicate that the electron donor level is between 0.22 eV and 0.28 eV. This was compared to the band gap energy of approximately 3.0 eV. Using the Hall effect the semiconductor was verified to be n-type and the mobility at room temperature was found to be 0.2 ± 0.12 cm^2/volt-sec. The capacitance and dissipation factor versus frequency data indicate that the relative dielectric constant in the reduced PZT was less than the dielectric constant of 480 for virgin PZT. The measurements also revealed that the dielectric properties of the PZT substrate are not significantly perturbed during the depletion process. The dielectric properties were investigated by using a simple double layer series-parallel resistance-capacitance model. (auth)

49749 ELECTROCONDUCTIVITY AND HEAT CONDUCTIVITY OF TRANSITION METALS OF GROUPS IV–VI IN THE REGION 20 TO 1200°C. L'vov, S. N.; Mal'ko, P. I.; Nemchenko, V. F. (Kherson State Pedagogical Inst., USSR). Metallofizika; No. 37, 22-9(1971). (In Russian).

The temperature dependence of the electrical resistance and thermal conductivity of Groups IV to VI transition metals (Ti, V, Cr, Zr, Nb, Mo, Hf, Ta, W) was studied in the temperature range 300 to 1,500°K. The magnitude of these parameters fluctuated periodically during the transition from metal to metal. The thermal dependence of the electrical resistance was nonlinear, and the thermal conductivity decreased with temperature rise. Deviations from linearity were interpreted in terms of the dependence of the Debye temperature on the thermal expansion of the lattice, and by the low spacing of the Fermi level in the generalized s-d zone. The Wiedemann–Franz law for the metals studied was fulfilled only qualitatively. The Lorenz number for the majority of metals was below the theoretical. (tr-auth)

49750 ANOMALOUS BEHAVIOR OF THE ELECTRIC RESISTANCE AND THERMOELECTRIC POWER OF METALLIC SAMARIUM AT HIGH TEMPERATURES. Vedernikov, M. V. (Ioffe Inst. of Physics and Tech., Leningrad). JETP Lett. (USSR) (Engl. Transl.); 15: No. 6, 230-2(20 Mar 1972).

Translated from Zh. Eksp. Teor. Fiz., Pis'ma Red.; 15: No. 6, 326-8(20 Mar 1972).

The electric resistivity and absolute differential thermoelectric power of >99.44% pure Sm were measured at 300 to 1000°K. The behavior of both properties change at 780 to 800°K. The results and published magnetic susceptibility data indicate that the transition at 780 to 800°K is magnetic, and that a magnetic disordering occurs at that temperature. (D.L.C.)

49751 INTERSTITIAL-ELECTRON MODEL FOR THE STRUCTURE OF METALS AND ALLOYS. II. ELECTRONIC

STRUCTURE OF METALS OF GROUPS I–V. Johnson, Oliver (Hokkaido Univ., Sapporo). Bull. Chem. Soc. Jap.; 45: No. 6, 1607-12(Jun 1972).

The interstitial-electron model leads to metal structures which are instantaneous pictures of electron distribution written in terms of metal ion core charge M^{n+} (n = valency) and numbers of electrons in octahedral or tetrahedral interstices. On the average there are conduction electrons ($\bar{e}$) in all interstices, and the degree of electron localization is small in metals. Decisions as to electron occupancy of interstices are primarily based on considerations of $\bar{e}$ spin and of screening of $\bar{e}$ by ion cores, but electronic heat capacity, Hall coefficient, and anisotropy in magnetic susceptibility are of use in making decisions on electron occupancy of interstices. For univalent metals, there is little localization of $\bar{e}$ because of the large excess of vacant interstices. This is also true when interstices approach full occupancy by $(\bar{e})_2$ as in M^{4+} and M^{5+}. Among divalent and trivalent metals, the preferential occupancy of interstices leads to considerable localization of $\bar{e}$ density for Be, Sc, Y, and Tl. This high degree of localization is a consequence of mutual polarization of ion cores and $\bar{e}$; it accounts for the lattice distortion in these metals and leads to other unusual properties. (auth)

49752 BASIC FACTS AND CURRENT RESEARCH ON THE POSITRON ANNIHILATION PROCESS. Berenyi, D.; Seif El Nasr, S. A. H. (Ein-Shams Univ., Cairo). ATOMKI (At. Kut. Intez.) Kozlem.; 13: No. 4, 137-63(1971).

A survey is presented of the physics of positron annihilation and of its applications in solid-state physics and chemistry and the physics of aggregate matter. Mean lifetime, positronium formation, three-quantum annihilation, angular correlation, annihilation in flight, single-quantum and radiationless annihilation, bound states, and excited states and hyperfine splitting in positronium are discussed. Measurement methods for positron annihilation are listed. The use of time distribution and angular distribution of annihilation radiations to study the structure of aggregate matter is discussed. Measurements of the annihilation line are reviewed. Problems and current research topics in the positron annihilation field are tabulated. (16 figures, 109 references). (D.L.C.)

49753 SIMULTANEOUS ADSORPTION OF CESIUM AND BARIUM ONTO TUNGSTEN AND NIOBIUM CRYSTAL SURFACES. Konoplev, Yu. M.; Naumovets, A. G.; Fedorus, A. G. (Inst. of Physics, Kiev). Sov. Phys.-Solid State(Eng. Transl.); 14: No. 2, 273-8(Aug 1972).

Translated from Fiz. Tverd. Tela- 14: No. 2, 326-33(Feb 1972).

The work function and thermal stability of cesium–barium films of various compositions on (110) tungsten and (100) tungsten and niobium surfaces were studied to derive information about the interaction between different types of adsorbed particles by the contact potential difference method. Results show that the adsorption interaction of barium with tungsten and niobium (100) surfaces is complex (and apparently reconstructional in nature). It was shown that the minimum values of the work function for mixed films are intermediate between the corresponding values for the pure components, being reached at lower cesium adatom concentrations and greater amounts of preferentially adsorbed barium. At low coverages by films of differing chemical compositions, preferential adsorption onto the surface and similar work function changes have an identical effect on the cesium heat of adsorption. The work function change can therefore be used as a parameter to describe the changes in surface conditions due to long-range interactions. At high coverages the adatom interaction is essentially short range and, in this case, differences in the chemical nature of the adsorbants in the vicinity of the particles can influence the adsorption characteristics. (auth)

49754 LONG-WAVE OPTICAL VIBRATION SPECTRUM OF VANADIUM PENTOXIDE. Reshina, I. I. (Inst. of Semiconductors, Leningrad). Sov. Phys.-Solid State(Eng. Transl.); 14: No. 2, 287-90(Aug 1972).

Translated from Fiz. Tverd. Tela- 14: No. 2, 345-9(Feb 1972).

The long-wave optical lattice vibration spectrum of a V_2O_5 single crystal was studied by Raman scattering and reflection spectra of a single crystal and the transmission spectrum of a powder. The frequencies and symmetry types of the optical vibrations were determined. (auth)

49755 VACANCY EQUILIBRIUM AND THERMAL EXPANSION OF TUNGSTEN AT HIGH TEMPERATURES. Kraftmakher, Ya. A. (Inst. of Inorganic Chemistry, Novosibirsk, USSR). Sov. Phys.-Solid State(Eng. Transl.); 14: No. 2, 325-7(Aug 1972).

Translated from Fiz. Tverd. Tela- 14: No. 2, 392-4(Feb 1972).

A modulation method is used to study the thermal expansion of tungsten between 2000 and 2900°K. The nonlinear increase in the thermal expansion coefficient is used to calculate the equilibrium vacancy concentration. If the volume of a vacancy is assumed to be half the atomic volume, then it is described by the expression $C = 450 \cdot \exp(-3.15/kT)$ which is close to a result found previously from measurements of the heat capacity. (auth)

49756 OPTICAL ABSORPTION IN TUNGSTEN AT T = 77°K. Nomerovannaya, L. V.; Kirillova, M. M.; Noskov, M. M. (Inst. of Metal Physics, Sverdlovsk, USSR). Sov. Phys.-Solid State (Eng. Transl.); 14: No. 2, 541-2(Aug 1972).

Translated from Fiz. Tverd. Tela- 14: No. 2, 633-5(Feb 1972).

Measurements were made of the dispersion of the refractive index and absorption coefficient of W single crystals at 77 and 295°K in the spectral range 4.2 to 0.302 μ. The structure of the transmittance curve is very sensitive to surface quality. The interband transitions of W are considered; where the 295°K data show several peaks, the 77°K data has only one peak, at 0.44 eV, which is due to the spin-orbit coupling parameter ξ_{5d}. (D.L.C.)

49757 MAGNETIC STUDY ON $Zr_xTa_{1-x}Co_2$. Aoki, Y.; Yamamoto, M.; Haryu, Y. (Tohoku Univ., Sendai). Phys. Status Solidi (b); 52: No. 2, K95-7(1 Aug 1972).

X-ray lattice parameter and magnetic susceptibility measurements were conducted on Lowes-phase $Zr_xTa_{1-x}Co_2$ over the entire composition range x = 0 to 1. The two compounds $ZrCo_2$ and $TaCo_2$ were found to be completely miscible, with the lattice parameter increasing linearly with x. The susceptibility data for 4.2 to 295°K show that each alloy is paramagnetic above 4.2°K, but that the Curie–Weiss law cannot be directly used; the paramagnetism is of the band type observed in transition metals and their alloys. (D.L.C.)

49758 MEASUREMENTS OF THE POLARIZABILITY OF TUNGSTEN ADATOMS ON TUNGSTEN (110) PLANES. Tsong, T. T.; Walko, R. J. (Pennsylvania State Univ., University Park). Phys. Status Solidi (a); 12: No. 1, 111-17(16 Jul 1972).

It is shown that high-quality room-temperature field-ion images (FIM) can be obtained. Image contrast can be enhanced by using a Ne–Ar mixture. The enhancement is due to field adsorption of argon at room temperature. Using room-temperature FIM, one can observe the movements of individual adatoms on surface planes. Due to the lateral field gradient existing on surface planes, the adatoms generally are forced to migrate in the direction from the center to the edge of the plane. From the migration speed, the polarizability of the adatoms can be calculated. From the analysis and experimental data, the polarizability of tungsten adatoms on a tungsten (110) plane is found to be 9.2 Å^3. A comparison is made to that obtained from field evaporation rate measurements. (auth)

49759 INVESTIGATION OF THE SORPTION OF OXYGEN ON TUNGSTEN BY THE IONIZATION OF MOLECULAR BEAMS. Zingerman, Ya. P. (Inst. of Physics, Kiev). Sov. Phys.-Solid State (Engl. Transl.); 14: No. 1, 236-8(Jul 1972).

Translated from Fiz. Tverd. Tela; 14: No. 1, 285-8(Jan 1972).

The method described in Sov. Phys.-Solid State (Engl. Transl.) 4: 1344(1963) was used, in which a molecular O beam adsorbed on a target passes through an ionization chamber which is also traversed by a molecular flux reflected and desorbed from the same target. The ion current increase ΔI was separated into its components in order to study the adsorption kinetics. An electron gun was also used to stimulate the desorption of positive O ions and to determine changes in the work function ϕ. When a W grid was used as the target, $\Delta I = \Delta I_0'$, indicating an adsorption probability of unity. Results indicate two-layer adsorption on the W(100) face, with the first layer consisting of W–2O complexes (limiting $n \cong 2 \times 10^{15}$ atoms/cm^2 and $\Delta\phi \cong 2.0$ eV) and acting as the absorption centers for the second layer. The absorption kinetics is quite different in the first and second stages, with the adsorption probability decreasing from unity in the first stage but remaining constant at unity in the second stage. The adsorption mechanism and the likelihood of a preadsorption layer are discussed. (D.L.C.)

49760 INFRARED SPECTRA OF GLASS SYSTEMS $SrO–B_2O_3$ AND $BaO–B_2O_3$. Kasymova, S. S.; Milyukov, E. M.; Petrovskii, G. T. (Inst. of Chemistry, Tashkent). Uzb. Khim. Zh.; No. 1, 5-6(1972). (In Russian).

Peculiarities in structure of strontium and barium borate glasses were studied by means of the infrared spectra of $SrO–B_2O_3$ and $BaO–B_2O_3$ systems and a comparison with the spectrum of pure B_2O_3. On the basis of the data obtained, infrared spectra of these two-phase systems may be regarded as a superposition of the spectrum of almost pure B_2O_3 and that of the second oxide component. (K.S.W.)

49761 INTRODUCTION TO LATTICE DYNAMICS. Ghatak, A. K.; Kothari, L. S. Reading, Mass.; Addison-Wesley Publishing Company (1972). 240p. $11.50.

This textbook discusses topics related to lattice dynamics and its study by neutron scattering experiments. The chapters treat wave propagation in one-dimensional lattices, quantization of lattice vibrations in one dimension, elastic constants and waves, dispersion relation and quantization of lattice vibrations in three dimensions, phenomenological theory, specific heat of crystals, and theory of elastic and inelastic scattering of slow neutrons in solids. The bva and ket notation, direct and reciprocal lattices, and orthonormal and closure properties of polarization vectors are covered in appendices. Author and subject indexes are included. (D.L.C.)

49762 SPIN POLARIZATION OF TUNNELING ELECTRONS FROM FILMS OF Fe, Co, Ni, AND Gd. Meservey, R.; Tedrow, P. M. (Massachusetts Inst. of Tech., Cambridge). Solid State Commun.; 11: No. 2, 333-6(15 Jul 1972).

Tunneling measurements of spin-polarized electrons from superconducting aluminum into films of Fe, Co, Ni, and Gd give the electron-spin polarization values of 44, 34, 11, and 4.3%, respectively. Their agreement with photoemission measurements makes explanations of the polarization based on the Stoner–Wohlfarth–Slater band model implausible. (auth)

49763 X-RAY INVESTIGATION OF ALLOYS IN THE V–Pd SYSTEM. Kurmaev, E. Z.; Belash, V. P.; Nemnonov, S. A.; Sorokina, M. F. (Inst. of Metal Physics, Moscow). Izv. Akad. Nauk SSSR, Ser. Fiz.; 36: No. 2, 312-16(Feb 1972). (In Russian).

The x-ray emission $K\beta_5$ bands of vanadium and L_{III} bands of palladium were investigated in the V–Bd system. The L_{III}-emission bands of Pd in alloys were close to the form and position of those of the pure element. The K spectrum of V in alloys had a definite two-band structure. Upon increasing the Pd content, a redistribution of the relative intensities of the sub-bands of the K spectrum occurred without change in their energy position. (tr-auth)

49764 X-RAY SPECTRA AND ELECTRON STRUCTURE OF BINARY ALLOYS OF VANADIUM WITH TRANSITION ELEMENTS. Nemnonov, S. A.; Kurmaev, E. Z.; Fomichev, V. A.; (and others) (Inst. of Metal Physics, Moscow). Izv. Akad. Nauk SSSR, Ser. Fiz.; 36: No. 2, 317-24(Feb 1972). (In Russian).

The outermost emission bands of the K- and M-series of vanadium as the pure metal and in binary alloys with the transition elements Fe, Co, Ni, Ru, Rh, Pd, Os, Ir, and Pt were investigated. In the spectra of the alloys V–25% Ru, V_3Rh, V_3Pd, VOs, V_3Ir, and V_3Pt, a splitting of the emission bands was observed in two fundamental sub-bands. The changes noted in the spectra of the alloys tested were associated with splitting of the d-bands of the components. (tr-auth)

49765 X-RAY SPECTRA OF ALLOYS IN THE Ti–Mo SYSTEM. Nemoshkalenko, V. V.; Nagornyi, V. Ya.; Nikolaev, L. I. (Inst. of Metal Physics, Moscow). Izv. Akad. Nauk SSSR, Ser. Fiz.; 36: No. 2, 411-14(Feb 1972). (In Russian).

The energy spectrum of Ti atoms was studied in alloys with Mo. The $K\beta_{2,5}$- and $L\alpha_{1,2}$ emission bands of Ti in the alloys in question were compared on the basis of a number of parameters. A decrease in the statistical weight of the p-symmetric states occurs during alloying in the peripheral energy band of Ti, and was accompanied by a simultaneous increase in the density of the d-symmetric states. (tr-auth)

49766 SPECIFIC HEAT OF ^{152}Sm METAL BETWEEN 0.45 AND 6 K. Lounasmaa, O. V.; Veuro, M. C. (Technical Univ. of Helsinki, Otaniemi, Finland). Phys. Lett.; 40A: No. 5, 371-2 (14 Aug 1972).

The heat capacity of an isotopically enriched (98.3%) ^{152}Sm metal specimen was measured. Because the nuclear contribution to C_P is absent in an even–even isotope, the electronic specific heat, $C_E = 13.5\ T\ mJ/mole \cdot K^2$, could be determined with higher accuracy (±2%) than before. (auth)

49767 SPIN POLARIZATION EFFECTS IN $Nd_{1-x}Ho_xCo_3$ COMPOUNDS. Narasimhan, K. S. V. L.; Butera, R. A.; Craig, R. S. (Univ. of Pittsburgh). Phys. Lett.; 40A: No. 5, 381-2(14 Aug 1972).

Magnetic moments and Curie temperatures were measured for $Nd_{1-x}Ho_xCo_3$ compounds. The cobalt moment was found to be nonlinear with x. This effect is attributed to spin polarization. (auth)

49768 SHEAR-MODE SPECTRUM IN Nb_3Sn. Saub, K. (Univ., Zagreb); Barisic, S. Phys. Lett.; 40A: No. 5, 415-16(14 Aug 1972).

Recent measurements of the shear mode spectrum in Nb_3Sn are interpreted in terms of the generalized Labbé–Friedel model. These measurements are shown to be consistent with the development of the pronounced Kohn anomaly at low temperatures. (auth)

49769 TRANSIENT MAGNETIC FIELD AT Gd IN FERROMAGNETIC GADOLINIUM. Skaali, B.; Ogaza, S.; Fleming, D. G.; Herskind, B. (Univ. of Copenhagen). Phys. Lett.; 40B: No. 4, 446-8 (24 Jul 1972).

The transient magnetic precession ϕ/g of Gd in ferromagnetic Gd was measured. The result, −171 ± 21 mr, is in agreement with present systematics of transient fields at nonrare-earth nuclei. (auth)

49770 SECONDARY ELECTRON EMISSION FROM THE (112) FACE OF A MOLYBDENUM SINGLE CRYSTAL. Arifov, U. A.; Vakhidov, U. V.; Kasymov, A. Kh. (Tashkent Polytechnical Inst.). Izv. Akad. Nauk Uzb. SSR, Ser. Fiz.-Mat. Nauk; No. 5, 81-2(1971). (In Russian).

The secondary electron emission from the (112) face of a Mo monocrystal in a vacuum was studied at primary electron energies of 100 to 2,000 eV. The Mo crystal was obtained by zone melting, and a target was prepared by grinding with fine carborundum and then polished to a mirror finish with felt. The effect of high temperature (1800 or 2100°K) on electron emission was studied. An explanation in terms of a diffraction effect is offered. (K.S.W)

Moessbauer Effects and NMR

Refer also to abstracts 48163, 48164, and 49263.

49771 (COO–3246-2) RESEARCH IN NUCLEAR CHEMISTRY. Annual Report. Kaplan, Morton (Carnegie-Mellon Univ., Pittsburgh. Dept. of Chemistry). Jul 1972. Contract AT(11-1)-3246. 20p. Dep. NTIS.

- ARSENIC ISOTOPES As-74—nuclear magnetic resonance in iron, internal field and magnetic moment from
- ARSENIC ISOTOPES As-74—beta decay of, nuclear orientation study of mixing ratio of
- BISMUTH—hyperfine field in nickel
- EUROPIUM—ammine of, europium-151 Moessbauer effect in hexa-
- EUROPIUM ISOTOPES Eu-151—Moessbauer effect in europium hexammine
- IRON—arsenic-74 NMR in
- IRON CHLORIDES $FeCl_3$—magnetic interactions in hexahydrate of, Moessbauer effect studies of
- IRON ISOTOPES Fe-57—Moessbauer effect in ferric chloride hexahydrate
- LEAD ISOTOPES Pb-206—energy-level transition, mixing ratio of 497-keV gamma ray
- NICKEL—bismuth hyperfine field in

49772 POLARIZATION DEPENDENCE OF THE INTERFERENCE OF NUCLEAR AND ELECTRONIC γ-RAY SCATTERING. Artem'ev, A. N.; Sklyarevskii, V. V.; Smirnov, G. V.; Stepanov, E. P. JETP Lett. (USSR) (Engl. Transl.); 15: No. 6, 226-8(20 Mar 1972).

Translated from Zh. Eksp. Teor. Fiz., Pis'ma Red.; 15: No. 6, 320-3(20 Mar 1972).

In earlier investigations of interference phenomena in the diffraction of resonant γ rays, no singularities connected with the existence of sharp polarization dependence of the resonant nuclear scattering were observed. Here, conditions were created under which this dependence becomes clearly pronounced, particularly in the fact that different interference lines in the Moessbauer spectrum have different asymmetry directions. It is shown that the spectral lines have the clearly pronounced dispersion shape, which is typical of the interference of nuclear resonant and Rayleigh scattering. (M.H.R.)

49773 MAGNETIC ANOMALIES IN THE MOESSBAUER EFFECT. Belova, V. M.; Nikolaev, V. I. (Moscow State Univ.). Sov. Phys.-Solid State (Engl. Transl.); 14: No. 1, 111-16(Jul 1972).

Translated from Fiz. Tverd. Tela; 14: No. 1, 138-46(Jan 1972).

"Magnetic anomalies" in the temperature dependence of certain Moessbauer effect characteristics are discussed. Expressions are derived for estimating the order of magnitude of these anomalies caused by the presence of magnetic order in the spin system. The problem is discussed in the Debye approximation within the scope of the first-order perturbation theory for the case of cubic crystals. (auth)

49774 PARAMAGNETIC RESONANCE OF GADOLINIUM IN INTERMETALLIC COMPOUNDS YAl_2 AND $Y_{1-w}Th_wAl_2$. Schaefer, W. (Technische Hochschule, Darmstadt, Ger.); Schmidt, H. K.; Elschner, B.; Buschow, K.H.J. Z. Phys.; 254: No. 1, 1-9 (1972).

The paramagnetic resonance of Gd in YAl_2 was measured in the temperature range from 5 to 70°K. Results are discussed with Hasegawa's theory. The dependence of linewidth on temperature and Gd concentration indicates the existence of a "bottleneck" in the relaxation between the conduction electrons and the lattice. If nonmagnetic thorium impurities are added, an additional relaxation becomes effective, caused by spin-flip scattering of the conduction electrons at these impurities. In this case the bottleneck is removed. (auth)

49775 EFFECT OF ELECTRON EXCHANGE INTERACTIONS ON NUCLEAR RELAXATION. Buishvili, L. L.; Khalvashi, E. Kh. (Tbilisi State Univ., USSR). Phys. Status Solidi (b); 52: No. 2, 355-9(1 Aug 1972).

Nuclear relaxation is considered taking into account electron exchange interaction. An expression for the nuclear relaxation rate is obtained and it is shown that at exact resonance EPR saturation can produce NMR saturation under specified conditions. (auth)

Theory

49776 PRINCIPLES OF THE THEORY OF SOLIDS. SECOND EDITION. Ziman, J. M. Cambridge, Eng.; Cambridge University Press (1972). 448p.

The chapters are entitled: periodic structures, lattice waves, static properties of solids, electron—electron interactions, dynamics of electrons, transport properties, optical properties, Fermi surface, magnetism, and superconductivity. (UK)

PHYSICS (THEORETICAL)

Refer also to abstracts 48960, 48964, 49105, 49126, and 49502.

49777 (RLO–1388-620) DIAGRAMMATIC TECHNIQUES IN THE MARTIN–SCHWINGER–PUFF MANY-BODY THEORY. Crichton, James H.; Yu, Simon (Washington Univ., Seattle). [nd]. 54p. Dep. NTIS.

In an attempt to understand the connection between the Martin–Schwinger–Puff Green's function approach to the many-body problem and the diagrammatic approach of Brueckner and Goldstone, the perturbation expansion of the Green's function theory is studied. This expansion leads naturally to a representation of the theory by two sets of time-dependent diagrams—the kinetic energy diagrams and the potential energy diagrams. Rules are given for writing each time-dependent diagram as a sum of time-independent diagrams. Complications arise in the application of these rules to bubble diagrams. A special simple treatment of these diagrams is then proposed. There exists a simple relation between families of kinetic diagrams and potential diagrams. This relation stems from a rather general thermodynamic identity. Both the relation and its thermodynamic origin are described. (auth)

49778 GAUSSIAN WAVE FUNCTIONS AND THE MANY-BODY PROBLEM. Hall, R. L. (Queen's Univ., Kingston, Ont.). Can. J. Phys.; 50: No. 4, 305-11(15 Feb 1972).

A system of identical nonrelativistic particles is considered. It is shown that the wave functions for relative motion, which have the correct permutation symmetry, must satisfy two functional equations. In the case of bosons these equations are solved for those bound states where the wave function is also in a single-product form. The only solutions are Gaussian functions. Consequently these are the only functions which can reduce the N-body energy expectation to an integral over a single variable. Furthermore, it is shown that the reduced two-body Hamiltonian which in general gives energy lower bounds yields the exact energy of the entire system only for the Hooke's law interaction. Neither possibility is allowed by fermions. (auth)

49779 ONE-CENTER COULOMB, TWO-CENTER HYBRID, AND TWO-CENTER COULOMB INTEGRALS OVER STP FUNCTIONS. England, Walter (Ames Lab., Iowa). Int. J. Quant. Chem.; 6: No. 3, 509-18(May 1972).

Diatomic integral formulas involving Slater-transform-Preuss functions are obtained for the Coulomb and hybrid types. One-center Coulomb integrals are also considered. All results have finite sums containing a one-dimensional numerical integration. (auth)

49780 UPON A CONVERGENCE RESULT IN THE THEORY OF THE PADE TABLE. Wynn, P. (Louisiana State Univ., New Orleans). Trans. Amer. Math. Soc.; 165: 239-49(Mar 1972).

The main theorem is the following: Let M_ν, b_ν ($\nu = 1,2, \ldots, n$) be two sets of finite positive real numbers, with $b_1 > b_2 > \cdots > b_n$, and let $\sigma(s)$ be a bounded nondecreasing function for $a \leqq s \leqq b$ where $0 \leqq a \leqq b < b_n$; denote the Padé quotients derived from the series expansion of the function $f(z) = \Sigma_{\nu=1}^{n} [M_\nu/(1 + b_\nu z)] + \int_a^b [d\sigma(s)/(1 + zs)]$ in ascending powers of z by $\{R_{i,j}(z)\}$; let D be the open disc $|z| < b^{-1}$ cut along the real segment $(-b^{-1}, -b_1^{-1})$; define a progressive sequence of Padé quotients to be one in which the successor $R_{i'',j''}(z)$ to $R_{i',j'}(z)$ is such that either $i'' > i'$ and $j'' \geqq j'$ or $i'' \geqq i'$ and $j'' > j'$; then any infinite progressive sequence of quotients $\{R_{i,j}(z)\}$ for which $i \geqq n$ and $j \geqq n$ converges uniformly for $z \in D$ to f(z). The proof proceeds in a number of stages which are described. (J.F.P.)

49781 HYPERVIRIAL AND HELLMANN–FEYNMAN THEOREMS APPLIED TO ANHARMONIC OSCILLATORS. Swenson, Robert J.; Danforth, Scott H. (Montana State Univ., Bozeman). J. Chem. Phys.; 57: No. 4, 1734-7(15 Aug 1972).

A set of hypervirial theorems plus the Hellman–Feynman theorem are applied to a general anharmonic oscillator. The exact energy and expectation values of powers of the position coordinate are expanded in a power series of the anharmonic coupling constant and it is shown that use of the above theorems enables one to express each term in these expansions solely in terms of the unperturbed energy and known constants. This procedure thus eliminates the usual tedious calculations of sums over intermediate states of products of matrix elements which arise in nth order Rayleigh–Schroedinger perturbation theory. (auth)

49782 SOLUTION OF THE SCHROEDINGER EQUATION BY A UNIFIED ALGEBRAIC METHOD. Ixaru, L. Gr. (Inst. of Atomic Physics, Bucharest). Rev. Roum. Phys.; 17: No. 1, 7-20(1972).

A new method of solving the one-dimensional Schroedinger equation is treated. The proposed method is unified in the sense that both continuum and discrete spectrum problems are treated on the same footing. Its idea consists in the replacement of this equation by an algebraic system of linear equations. In order to derive this system the potential is approximated by a sequence of step functions, the wavefunction is written in each interval and the condition of being continuous and of admitting the first order derivative everywhere on the real axis (particularly at the joining points of two adjacent intervals) is imposed on it. The solution of the derived system is obtained by means of a recurrence formula. It is also shown how this method actually works for deriving eigenenergies and eigenfunctions in the discrete spectrum problems as well as wavefunctions and phase shifts in the continuum spectrum problems. Finally some special features of this method are investigated. (auth)

49783 THREE-BODY PROBLEM. Amado, Ralph D. (Univ. of Pennsylvania, Philadelphia). pp 1-123 of Elementary Particle Physics and Scattering Theory. Vol. 2. /Chretien, M. (ed.). New York; Gordon and Breach, Science Publishers, Inc. (1970).

The nonrelativistic quantum mechanical three-body problem is discussed. The lectures cover disconnectedness, variables, separable interactions, results on the three-nucleon system and some others, coherence, analyticity and thresholds, and on beyond the three-body problem. (J.F.P.)

49784 GUDDER'S HIDDEN-VARIABLE THEOREMS. Ochs, W. (Univ., Munich). Nuovo Cim.; 10B: No. 1, 172-84(11 Jul 1972).

Two versions of a theorem of Gudder about the inconsistency of hidden-variable theories are examined. By means of a counterexample it is demonstrated that the stronger version of Gudder's theorem is incorrect, whereas the weaker version is shown to rest upon an unacceptable assumption. (auth)

49785 NEW INTERPRETATION OF WAVE MECHANICS. VOLUME 1. GENERALITIES. De Broglie, Louis. Paris; Gauthier-Villars (1971). 194p. (In French).

An interpretation of wave mechanics in terms of the double solution theory and concealed particle thermodynamics is exposed. Applications of these general concepts are suggested. (France)

49786 QUANTIZING ORBITAL ANGULAR MOMENTUM VIA THE HARMONIC OSCILLATOR. Mikhailov, V. V. (Kazan Physical Technical Inst.). Phys. Lett.; 40A: No. 4, 343-4(31 Jul 1972).

The bases of orbital angular momentum eigenstates expressed through the homogeneous polynomials from 3-dimensional harmonic oscillator operators are explicitly constructed. The Bargmann and Schrödinger representations of these states are discussed. (auth)

49787 GENERALIZED RAYLEIGH–SCHROEDINGER PERTURBATION THEORY. Carbo, Ramon (Instituto Quimico de Sarria, Barcelona). Int. J. Quant. Chem.; 6: No. 4, 609-11 (Jul 1972).

The equivalence of the perturbation formalism, in the Rayleigh–Schrödinger framework, between secular and generalized secular equations is analyzed. (auth)

49788 LECTURES ON THE MANY-ELECTRON PROBLEM. Brout, R.; Carruthers, P. New York; Gordon and Breach, Science Publishers, Inc. (1969). 210p.

The lectures cover the many-body problem in classical statistical mechanics, field theoretic methods, the linked cluster expansion, quantum mechanical treatment for electron correlation, dielectric formulation of the many-body problem, and applications to the theory of metals. (J.F.P.)

49789 DERIVATION OF THE DIFFUSION COEFFICIENT OF STOCHASTIC QUANTUM MECHANICS. de la Pena-Auerbach, L.; Cetto, A. M. (Birkbeck Coll., London). Nuovo Cim.; 10B: No. 2, 592-8(11 Aug 1972).

The empirical formula $D = \hbar/2m$, common to all stochastic interpretations of quantum mechanics, is demonstrated under the assumption that the stochasticity is due to the presence of the zero-point radiation field. The demonstration is indirect and requires the calculation of the radiative correction to the energy of a harmonic oscillator as given by the stochastic theory of quantum mechanics; this approximate calculation does not involve any divergence or cut-off, and yields a result which is in good agreement with the prediction of quantum electrodynamics. (auth)

49790 HIDDEN-VARIABLE MODELS FOR QUANTUM MECHANICS. Gudder, S. (Univ. of Denver). Nuovo Cim.; 10B: No. 2, 518-22(11 Aug 1972).

A hidden-variable model for quantum mechanics is given. This model is essentially a quantum logic with a strongly order-determining set of dispersion-free states. A representation theorem which shows that this model is isomorphic to a class of subsets of a phase-space is proved. It is shown that Ochs' hidden-variable example is a special case of the general model and some comments are made about work by Ochs on hidden variables. (auth)

REACTOR TECHNOLOGY

Power Reactor Development

Refer also to abstracts 47654 and 49957.

49791 (BMBW-FBK-72-3) DEVELOPMENT OF A 300 MWe PROTOTYPE NUCLEAR POWER STATION WITH SODIUM COOLED FAST REACTOR SNR. Final Report, Interim Program. Slopianka, G. (Internationale Atomreaktorbau G.m.b.H., Bensberg (West Germany)). Mar 1972. 243p. (In German). Dep. NTIS (U. S. Sales Only).

A summarized description of the activities to be carried out is presented as a supplement to the bid proposal documents and to the safety report. The motivation for the changed concept (prismatic containment), the adaption of the thermo-hydraulic loops and buildings to this concept, and the testing in the work areas of nuclear physics and safety are described. Furthermore, results are reported on the experimental program, on the progress of the two large sodium-test facilities AKB and APB/RSB, as well as on numerous experiments on sodium technology. (auth)

49792 (GULF-GA-A-10999) HTGR BASE PROGRAM. Quarterly Progress Report for the Period Ending February 29, 1972. (Gulf General Atomic Co., San Diego, Calif.). 31 Mar 1972. Contract AT(04-3)-167. 64p. Dep. NTIS.

The High-temperature Gas-cooled Reactor (HTGR) development work reported includes studies of basic fission-product distribution mechanisms, recycle fuel studies (including designing and testing of recycle test elements) and exploration of head-end reprocessing methods (as part of a national recycle plan and of a recycle fuel plant), and physics and fuel management studies. Materials studies include irradiation and analysis of fuel particles in capsules to evaluate fuel systems, and basic studies of control materials and of carbon and graphite. Experimental procedures and results are discussed and, where appropriate, the data are presented. (auth)

49793 (JUL-825-RB) INDIRECT MEASUREMENT OF TEMPERATURES BY METALLIC MINIATURE MELTING BODIES. A. ON MODERATING BALLS IN THE CORE OF THE AVR REACTOR AT JUELICH. B. AT REACTOR EXPERIMENTS AT CADARACHE. Presser, Karl Heinz (Kernforschungsanlage, Juelich (West Germany). Institut fuer Reaktorbauelemente). Jan 1972. 61p. (In German). Dep. NTIS (U. S. Sales Only).

A procedure is given for measuring temperatures of moderating balls (fuel balls) in the core of the AVR reactor at Jülich. It is based on the deformation of metallic bodies of different deformation temperature during melting under the influence of surface tension. The melting bodies are made of the pure metals Ag, Au, Cu, Ni, and Pd, or of their binary alloys. The temperature region of 780–1555°C was covered. The melting bodies were surrounded by capsules of Al_2O_3 and situated in borings of the moderating ball. The measured temperatures are given from a first reactor experiment with 16 pebbles. Also a comparison is performed with theoretically calculated temperatures. Temperatures in filters for sorption of radioactive fission products were measured at reactor experiments at Cadarache. Accordingly the temperature regions from 50–150°C and 200–600°C were covered. Melting bodies were applied from the pure metals Sn, Bi, Tl, Cd, Pb, Te, and Sb, and from different eutectic alloys. These were situated in capsules filled with hydrogen; the capsules were made of pyrex glass and herasil-I. 9 references. (auth)

49794 (NP-19340) ANNUAL REPORT OF THE DEPARTMENT OF ATOMIC ENERGY, GOVERNMENT OF INDIA, 1971-72. (Department of Atomic Energy, Bombay (India)). 192p. Dep. NTIS (U. S. Sales Only).

The atomic energy research and development programs in India during 1971 and 1972 are reviewed. The review information is presented under the following headings: nuclear power; atomic minerals and fuels; industrial operations; agro-industrial complex studies; research and development; medical research and facilities; health and safety; management and training; international relations; and space research. (D.C.C.)

Physics and Core Engineering

49795 (AI-AEC-13025) LMFBR PHYSICS PROGRAMS. Quarterly Technical Progress Report, January-March 1972. (Atomics International, Canoga Park, Calif.). 25 May 1972. Contract AT-(04-3)-824. 33p. Dep. NTIS.

COPPER 63—neutron cross sections for, evaluation of ENDF/B data for, (E/T)
CRITICAL ASSEMBLIES—core for ECEL, mockup of sodium cooled fast
LIQUID METAL FAST BREEDER REACTOR—physics measurement programs during January to March 1972
NEUTRON CROSS SECTIONS—calculations for fast reactors, evaluation of ENDF/B data for, (E/T)
NEUTRONS, DELAYED—yields from fission of fast reactor fuels, review and evaluation of
REACTOR CONTROL ELEMENTS—fabrication of mockup sodium-filled fast
REACTORS, FAST—physics analysis of, development of IMPS and VIM codes for
—cores for, gamma heating rates in mockup, (E/T)
TUNGSTEN—neutron cross sections for, evaluation of ENDF/B data for, (E/T) (H.D.R.)

49796 (EUR-4837) COSTAX-BWR: A NUMERICAL PROGRAMME FOR THE AXIAL DYNAMICS OF BWR NUCLEAR REACTORS. Forti, G. (European Atomic Energy Community, Ispra (Italy). Joint Nuclear Research Center). 1972. 59p. Dep. NTIS (U. S. Sales Only). EUR B. Fr. 85.-.

The computer program COSTAX-BWR is a development and a specialization of the previous COSTAX-BOIL code for the dynamics of BWR nuclear reactors. One-dimensional neutron diffusion equations in two energy groups and plane geometry are coupled to boiling coolant channel thermohydrodynamics and heat conduction in cylindrical fuel rods. Slow pressure transients are permitted and water properties as function of pressure are built into the code in the range 30 to 100 bar. The two-phase Bankoff's model for the coolant channel has been extended to include local vapor drift according to Zuber's theory. Subcooled boiling and vapor recondensation are accounted for. The code performs a complete converged neutronic and thermal steady state calculation, including criticality search according to different options before starting a transient. Any kind of transient may be simulated: rod drop, loss of coolant flow, inlet enthalpy excursions, or any combination of them. (auth)

49797 (EURFNR-931) GAS BREEDER MEMORANDUM: RESULTS OF A STUDY ON THE FEASIBILITY AND PROFITABILITY OF A GAS-COOLED FAST BREEDER. (Kernforschungszentrum, Karlsruhe (West Germany)). Translation of report KFK-1375. 533p. Dep. NTIS.

Work performed under United States-Euratom Fast Reactor Exchange Program.

The feasibility and economics of a gas-cooled fast breeder (GCFB) are studied. Measures which should be taken in the event that the sodium-cooled fast breeder does not fulfill its technical and economic expectations are discussed. The design of a GCFB can be based on known techniques. Experience gained in the construction and operation of gas-cooled thermal reactors can be used. Unlike the steam-cooled breeder reactor, the GCFB has favorable breeding properties and its potential as regards fuel consumption is close to the sodium breeder. 170 references. (auth)

49798 (GEAP-13249) ANALYSIS OF TRANSIENT CRITICAL HEAT FLUX. Lahey, R. T. Jr.; Shiralkar, B. S.; Gonzalez, J. M.; Schnebley, L. E. (General Electric Co., San Jose, Calif. Atomic Power Equipment Dept.). Feb 1972. Contract AT(04-3)-189. 204p. Dep. NTIS.

A simplified analytical technique, based on the method of characteristics, which allows one to predict the onset of transient Critical Heat Flux (CHF) was developed. Exact solutions were obtained for the exponential flow decay case, and computer codes were developed to handle more general cases of interest. Comparisons of the analytical predictions with transient void fraction and CHF data indicate good agreement, although the CHF predictions are generally somewhat conservative. Moreover, comparisons of the analytical predictions with those given by Zuber's void propagation analysis indicate good agreement, which tends to independently support the assumptions made in the subject analysis. 11 references. (auth)

49799 STRUCTURAL MATERIALS ASPECTS OF LMFBR CORE RESTRAINT SYSTEM DESIGN. Pennell, W. E. (Westinghouse Electric Corp., Madison, Pa.). Nucl. Technol.; 16: No. 1, 332-44(Oct 1972).

Core restraint system design experience has shown the irradiation creep and swelling design equations to be valuable design tools. The principal difficulty encountered in using these equations occurs when the two effects must be superposed, particularly when creep is used to offset the effects of swelling. The difficulty arises due to the wide range of results obtainable within the swelling-creep confidence limit envelope. An improved understanding of swelling-creep superposition behavior would be of considerable benefit to the core restraint system designer. The slit-tube test offers a near term means of obtaining some swelling-creep superposition data. (13 references) (auth)

Control and Instrumentation

49800 (BAW–10003(Rev.1)) QUALIFICATION TESTING OF PROTECTION SYSTEM INSTRUMENTATION. (Babcock and Wilcox Co., Lynchburg, Va. Power Generation Div.). May 1972. 106p.

Protection system instrumentation is used in Babcock & Wilcox nuclear steam systems to initiate protective functions. The instrumentation includes the nuclear instrumentation and reactor protection system (NI/RPS) and the safety features actuation system (SFAS). Safety-oriented instrumentation must be very reliable, and qualification testing is required to verify that the design of the protective system equipment meets this requirement. The qualification testing was conducted in six phases. (1) System electronic module performance tests. (2) Remote sensor performance tests. (3) Long-term operational tests of the nuclear flux channels of the NI/RPS at an operational reactor. (4) Environmental tests of all system modules and components. (5) Seismic tests on all system modules and components. (6) Failure analysis of the coincidence logic modules. The results of these tests are summarized as follows: (1) All of the system's electronic modules meet or exceed all of their design requirements for electronic performance for both normal (reference) operating conditions and for the entire design range of power supply, environmental, and seismic conditions. (2) All other system components, including all remote sensors, meet or exceed all of their design performance requirements for normal operating conditions and for the entire design range of environmental and seismic conditions. (3) The nuclear instrumentation system performed as required for one year at an operating reactor. (4) Any single failure of the coincidence logic modules will not prevent a required protective action, nor will it result in a false protective action. The failure would be detectable by normal operational testing. (auth)

49801 (BAW–10047) STUDY OF DISCONTINUITIES IN CONTROL ROD DRIVE MOTOR TUBE EXTENSIONS. Johnson, T. O.; Ayres, P. S.; Echelbarger, G. J.; Lawrie, W. E. (Babcock and Wilcox Co., Lynchburg, Va. (USA). Nuclear Power Generation Div.). Jun 1972. 57p.

Some control rod drive motor tube extensions have exhibited variations in wall thickness and discontinuities on the inner surface of the tube. An extensive investigation of these conditions is discussed and a program for resolving the findings is described. (auth)

49802 (WCAP–7769(Rev.1)) OVERPRESSURE PROTECTION FOR WESTINGHOUSE PRESSURIZED WATER REACTORS. Topical Report. Cooper, K.; Starek, R. M.; Miselis, V.; Sarver, S. J.; Mangan, M. A. (Westinghouse Electric Corp., Pittsburgh, Pa.). Jun 1972. 104p.

The procedure used to establish the pressurizer and steam generator safety valve capacities for Westinghouse Pressurized Water Reactors (PWR) is described. An evaluation of the system overpressure protection provided by the pressurizer safety valves, steam generator safety valves, and reactor protection system is included for the limiting plant configuration. The analysis results included show that the system overpressure protection provided by Westinghouse PWR systems satisfies the pressure relief requirements of Section III of the ASME Boiler and Pressure Vessel Code. The results of the analysis show that the sizing procedure is conservative in that the pressurizer and steam generator safety valve relief capacities provided are greater than that required for system overpressure protection during the transients analyzed. (auth)

Containment Systems, Waste Processing, and Radiation Protection

Refer also to abstract 47915.

49803 (RDT-E–14-5-T(6-72)) INFLATABLE SEAL-CONTAINMENT VESSEL AIRLOCK. (Division of Reactor Development and Technology (AEC), Washington, D. C.). Jun 1972. 11p. RSO.

The requirements for the design, manufacture, installation, and test of inflatable seal installations for sealing large doors in power reactor containment structure airlocks are presented. (D.C.C.)

49804 (WCAP–7820) ELECTRICAL HYDROGEN RECOMBINER FOR WATER REACTOR CONTAINMENTS. Wilson, J. F. (Westinghouse Electric Corp., Pittsburgh, Pa.). Dec 1971. 37p.

The development of an electric hydrogen recombiner for use in water reactor containments is described. The development effort completed to date includes analytical work and proof-of-principle tests. Excellent results have been obtained and the merits and feasibility of the electric hydrogen recombiner design are demonstrated. (auth)

49805 COST ASSOCIATED WITH EFFLUENT RADIATION FROM NUCLEAR POWER PLANTS. Leonard, James; Baer, Thomas S. (Univ. of Cincinnati). pp 393-7 of Institute of Environmental Sciences 1972 Proceedings. Environmental Progress in Science and Education. Mt. Prospect, Ill.; Inst. of Environmental Sciences (1972).

From eighteenth annual meeting on environmental progress in science and education, New York, NY. (1 May 1972). See CONF-720511.

Cost estimates are presented for revised power reactor radioactive waste processing systems with increased performance characteristics. (6 references) (D.C.C.)

49806 TRANSPORTATION OF RADIOACTIVE MATERIAL FROM A LARGE NUCLEAR POWER PLANT. Pirro, John (Burns and Roe, Inc., New York). pp 400-6 of Institute of Environmental Sciences 1972 Proceedings. Environmental Progress in Science and Education. Mt. Prospect, Ill.; Inst. of Environmental Sciences (1972).

From eighteenth annual meeting on environmental progress in science and education; New York, NY. (1 May 1972). See CONF-720511.

The packaging and transporting requirements of radioactive materials from nuclear power plants are described. Packaging classifications are discussed. Radioactive material classifications are defined. (D.C.C.)

Coolant System

49807 (CISE-R–248) PDE-MO: MODIFIED VERSION OF THE DIGITAL PROGRAM PDE FOR THE THERMOHYDRAULIC PROJECT OF THE CIRENE REACTOR. Muscettola, M. (Centro Informazioni Studi Esperienze, Milan (Italy)). Nov 1967. 127p. (In Italian). Dep. NTIS (U. S. Sales Only).

A modified version of the digital program PDE is presented. The program PDE was set up to compute the pressure conditions, the densities, and the energy and mass content in a boiler. Together with the power transferred to the fluid and the steam drum pressure, the inlet mass flow rates and enthalpies are given as input. In the project of the core cooling circuit of the nuclear reactor of the CIRENE type the latter quantities are computed, rather than imposed. The mass flow rates are chosen so that the required safety margin with respect to the heat transfer crisis is achieved at the outlet of every channel. The inlet enthalpy is determined by the over-all heat balance of the core. The program PDE-MO has been set up to perform automatically these calculations. After inlet mass flow rates and enthalpies have been computed the program computes, as the program PDE, the densities, and the mass and energy content in the circuit. The hydraulic schemes which can be considered by the program are the same as the schemes considered for the PDE, with the only exception that the circuit may not be wholly adiabatic. Only the changes introduced in the program PDE are described in detail. A complete description of the input and of the output is given together with the FORTRAN IV list for IBM 7040. (auth)

49808 (HEDL-TME–71-129) FFTF/LMFBR METHODS FOR SODIUM LEAK DETECTION, FIRE PREVENTION, AND FIRE CONTROL. (Hanford Engineering Development Lab., Richland, Wash.). Aug 1971. Contract AT(45-1)-2170. 64p. Dep. NTIS.

The problems of sodium leaks and their detection and control for the FFTF and LMFBR projects are discussed. Safety aspects are considered, especially with regard to fire prevention and control. (J.M.J.)

49809 (JUL–833-HT) TRANSPIRATION COOLING: AN ALTERNATIVE FOR ISOLATION OF HOT GAS MAINS OF NUCLEAR POWER PLANTS WITH HIGH-TEMPERATURE REACTOR AND HELIUM TURBINE. Terkessidis, Johann (Kernforschungsanlage, Juelich (West Germany)). Feb 1972. 22p. (In German). Dep. NTIS (U. S. Sales Only).

In comparison to other power plants, a compatibility of nuclear power plants with high-temperature reactor and helium turbine exists only where an energy change in the region of high temperatures occurs. The hot gas main connecting the reactor and the turbine is one of the components which is subject to high temperatures (800°C and higher). With regard to the life-time of these power plants and in reference to therewith associated material strains, one cannot yet refer to sufficient testing; also, an application of the topical high-temperature materials cannot be considered for cost reasons. In order to find another appropriate solution one has to start from the fact that as usual either heat isolation or cooling is in question for that purpose. By theoretical considerations performed and presently available computations, the attempt is made to present an appropriate application of transpiration cooling at hot gas mains of high-temperature reactors, as a special kind for isolation, and simultaneously to demonstrate an economic solution of this problem. 12 references. (auth)

49810 (RDT-C-12-1-T(5-72)) GAS CHROMATOGRAPH SYSTEM FOR SODIUM COVER GAS SERVICE. (Division of Reactor Development and Technology (AEC), Washington, D. C.). May 1972. 16p. RSO.

The standard establishes the requirements for the design, materials, quality assurance, fabrication, examination, acceptance testing and delivery of a gas chromatograph system (including analyzer section and control and readout section) for the continuous on-line measurement of trace impurities in the inert gas used as a cover for liquid sodium. The cover gas sample delivered to the gas chromatograph system shall not exceed 1 ppM of sodium vapor. (auth)

Fuels and Fuel Elements

Refer also to abstracts 47931–47935, 47937, 47938, and 48312.

49811 (ANL-7787) EFFECTS OF DRIVER-FUEL CLADDING DEFECTS ON THE OPERATION OF EBR-II. EBR-II Project. Smith, R. R.; Fryer, R. M.; Ebersole, E. R.; Loewenstein, W. B.; Strain, R. V. (Argonne National Lab., Ill.). Feb 1972. Contract W-31-109-eng-38. 98p. Dep. NTIS.

The various modes of fission-product release from an EBR-II driver-fuel element are reviewed in detail. The results of studies concerned with pressure buildup in the plenum of a fuel element are cited, and it is shown that near the end of life, the pressure may become high enough to unbond fuel material by driving bond sodium from the heat-transfer annulus through a low-elevation defect. The effects of voids in the heat-transfer annulus are discussed in the framework of simulation experiments conducted in TREAT and first-principle heat-transfer calculations. These studies show that the short-term consequences of fuel unbonding are benign. Mathematical models for the various modes of fission-product release are described and correlated with observations on actual fission-product releases. Guidelines for the number of defective driver-fuel elements that may be tolerated without affecting the annunciative capability or without aggravating radiological conditions are also described. 40 references. (auth)

49812 (ANL-7879) CHEMICAL ENGINEERING DIVISION: BURNUP, CROSS SECTIONS, AND DOSIMETRY SEMIANNUAL REPORT, JULY–DECEMBER 1971. Larsen, R. P.; Dudey, N. D.; Crouthamel, C. E.; Tevebaugh, A. D.; Vogel, R. C. (Argonne National Lab., Ill.). May 1972. Contract W-31-109-eng-38. 43p. Dep. NTIS.

Research and development efforts of the burnup, cross sections, and dosimetry programs in the Chemical Engineering Division of Argonne National Laboratory are reported for the period July to December 1971. Work was done in the following areas: measurements of fast-neutron fission yields of gamma-active fission products for samples of ^{235}U, ^{238}U, ^{239}Pu, and ^{237}Np irradiated in neutron spectra typical of EBR-II; measurements of fast-neutron tritium yields from ^{235}U fission using two independent methods; experimental techniques developed for characterizing fast-neutron spectra by means of activation-rate measurement; and a detailed analysis of calibration procedures and errors associated with absolute gamma-ray counting by means of Ge(Li) detectors. 19 references. (auth)

49813 (CONF-720607-6) PREDICTION OF LMFBR FUEL ROD START-UP BEHAVIOR. Harbourne, B. L.; Foster, J. P.; Biancheria, A. [(Westinghouse Electric Corp., Madison, Pa. Advanced Reactors Div.)]. [9 Feb 1972]. Contract AT(11-1)-3045. 4p. Dep. NTIS.

From eighteenth annual American Nuclear Society conference; Las Vegas, NV. (18 Jun 1972).

49814 (EUR-4794) PLUTONIUM RECYCLE IN ENEL'S LIGHT WATER REACTORS. Ariemma, A.; Belelli, U.; Paoletti Gualandi, M.; Rosa, I.; Sani, L.; Zaffiro, B. (Ente Nazionale per l'Energia Elettrica, Rome (Italy)). 1972. 118p. Dep. NTIS (U. S. Sales Only). EUR B. Fr. 165.-.

The studies carried out for the selection of the reactor for the irradiation program with plutonium prototype assemblies are briefly summarized. A detailed description is given for the calculation methods and codes used for the design of the plutonium prototype assemblies that have been in the Garigliano reactor since summer 1968. The main results are presented of the experimental activities carried out under the program and, in particular, the results of the criticality measurements in the Garigliano reactor, of the gamma-scanning on the core containing twelve irradiated prototype assemblies, and of the post-irradiation measurements on an enriched-uranium assembly irradiated to about 10,000 MWd/MTU. The operating experience gained up to mid-1970 with sixteen prototype plutonium assemblies is also summarized. At that date, the prototype assemblies had reached an average irradiation level of 7,000 MWd/MTM with a lead assembly value of 7,500 MWd/MTM. The results are presented of the optimization studies to determine the plutonium value, particularly where the plutonium is blended with depleted uranium recovered from the reprocessing of Magnox reactor fuel. Finally, areas that require further studies for a specific reactor are indicated. 36 references. (auth)

49815 (EURFNR-967) DESIGN, IRRADIATION, AND TESTING OF UO_2 FUEL PINS IN THE FR-2 CAPSULE TEST GROUP 3. Geithoff, D.; Freund, D.; Kummerer, K. (Kernforschungszentrum, Karlsruhe (West Germany). Institut fuer Material- und Festkoerperforschung). Translation of report KFK-1239. 278p. Dep. NTIS.

Work performed under United States–Euratom Fast Reactor Exchange Program.

In an irradiation experiment called "Capsule Group No. 3" 34 fuel pins were irradiated in a thermal flux in the FR 2-Reactor. The pins contained UO_2-pellets or vibrocompacted UO_2-particles as fuel with stainless steel cladding. In some specimen CeO_2 had been added for chemical simulation of PuO_2. At rod powers up to 700 W/cm and cladding temperatures around 600°C burnups up to 85 Mwd/kg M were achieved. Postirradiation examination of the pins showed the typical restructuring of the fuel (formation of central voids, radial cracks) while there were no visible effects on the cladding. 9 references. (auth)

49816 (JPRS-55882) STUDY OF THE BUILDUP OF PLUTONIUM ISOTOPES IN THE FUEL OF THE VVER-1 REACTOR OF THE NOVO-VORONEZHSKII ATOMIC POWER STATION. Gabeskiriya, V. Ya.; Belokopytov, V. S.; Miller, O. A.; Simakin, G. A.; Burnyakov, L. I.; Pakhomov, Z. I.; Vladimirova, N. A.; Matyashchuk, I. V. (Scientific Research Atomic Reactor Inst., Melekess (USSR)). Translation of report SRARI-P-66. 11p. NTIS.

49817 (KFK-1324) POST-IRRADIATION INVESTIGATION WITH THE MICROPROBE ON UO_2 AND $(U,Pu)O_2$ FUEL ELEMENTS OF THE TEST SERIES 3 AND 4a OF THE FR2 CAPSULE IRRADIATIONS. Huber, H.; Kleykamp, H. (Kernforschungszentrum, Karlsruhe (West Germany). Institut fuer Material und Festkoerperforschung). 23 Feb 1972. 78p. (In German). Dep. NTIS (U. S. Sales Only).

Postirradiation studies with the shielded microprobe analyzer were performed on UO_2 and $(U_{0.85}Pu_{0.15})O_2$ fuel elements of the number 3 and 4a test series of the FR2 capsule irradiations. The main topics of the thermal neutron irradiated specimens up to about 6.5% burn-up were: radial distribution of U and Pu; distribution of fission products in the fuel and at the cladding; and compatibility of the fuel with the cladding. A decrease of the U concentration was observed in the outer region of the UO_2 fuel (11.5% ^{235}U) based on the flux depression and the corresponding decrease of fission density in the inner region. A large increase of the Pu concentration near the central void combined with a flat minimum in the outer region of the columnar grain zone was established in the mixed oxide fuel. Both these effects are primarily based on the thermal diffusion of PuO_2 in the thermal gradient. The behavior of the U concentration is complementary. The composition and distribution of various metallic and oxide fission product inclusions which in part contain the components of the cladding material stainless steel 1.4988 were investigated. In addition to the known metallic inclusions consisting of Mo, Tc, Ru, Rh and small amounts of Pd, furthermore Pd, Sn and Te containing phases and Fe rich precipitations together with Pd, Ni, Mo and Tc were observed. On the other hand several oxide phases containing Cs, Sr, Ba, Zr, Mo and probably Cr were found. No incompatibilities were established at the fuel-cladding interface of the UO_2 fuels. On the contrary reactions were observed in the mixed oxide specimens with the exception of those with the minimum burn-up of 1.3%: cladding material was transported into the fuel up to about 1.2 mm, most extensively Fe, in smaller amounts Ni. Furthermore an intergranular and layerwise attack of the cladding with reaction zones up to 0.2 mm were established. Cr was enriched on grain boundaries or at the surface of the cladding, the behavior of Ni and especially of Fe was complementary. Moreover enrichments of Cs, Ba, Mo and Te at the fuel cladding interface were detected. The implications of these results are discussed in connection with future postirradiation studies. 39 references. (auth)

49818 (ORNL-TM-3693) ELECTRONIC CIRCUIT FOR THE PROTECTION OF CARTRIDGE HEATERS SIMULATING FAST REACTOR FUEL PINS. Stulting, R. D. (Oak Ridge National Lab., Tenn.). Jul 1972. Contract W-7405-eng-26. 19p. Dep. NTIS.

An electronic crowbar circuit was developed to prevent electrical faults from melting holes in the sheaths of cartridge electric heaters designed with one lead grounded to the sheath. The heaters simulate fuel pins in the Liquid Metal Fast Breeder Reactor (LMFBR) fuel failure mockup (FFM) sodium system and are fed from a variable "on-off" power supply. A fast acting circuit will detect a fault and turn on silicon controlled rectifiers (SCRs) that short circuit the heater leads. The short circuit reduces the supply voltage and limits the heater fault current. The power supply and SCRs are protected by current limiting fuses. Small overcurrent faults are detected, and the short circuit is applied in approximately 150 microseconds. Details of the design, operation, and tests are presented. (auth)

49819 (WCAP-3385-30) SAXTON PLUTONIUM PROJECT. Quarterly Progress Report for the Period Ending December 1971. Caye, T. E. (Westinghouse Electric Corp., Pittsburgh, Pa. Nuclear Fuel Div.). Dec 1971. Contract AT(11-1)-3044. 28p. Dep. NTIS.

PLUTONIUM—utilization in pressurized water reactor fuels, (E/T)
REACTORS, PRESSURIZED WATER—fuels for, utilization of plutonium in, (E/T)
SAXTON POWER REACTOR—operation during October through December 1971
—fuel elements in, performance of plutonium enriched, (E/T)
—fuel elements in, post operation inspection of, (E) (J.M.J)

49820 EXAMINATION OF F3A SERIES UNENCAPSULATED MIXED-OXIDE FUEL PINS IRRADIATED IN EBR-II. McCarthy, W. H. (General Electric Co., San Jose, Calif.); Perry, K. J.; Hull, G. R.; Bennett, J. W. Nucl. Technol.; 16: No. 1, 171-86 (Oct 1972).

Sixteen unencapsulated mixed-oxide fuel pins were irradiated in EBR-II to approximately 5 atomic percent burnup at 16 kW/ft nominal peak linear power. The fuel fabrication parameters were varied within the ranges proposed for commercial liquid metal fast breeder reactors (LMFBR) except that pin diameter was approximately 15% larger than usually specified. No cladding failures occurred. Pin growth was substantially greater in Type-304L stainless steel clad fuel pins than in Type-316 clad elements. Fission gas release to the internal void volume ranged from 73 to 97%. Experimental burnup values were 10 to 12% less than calculated values and varied across the subassembly in a manner that indicated a significant fission rate elevation from an adjacent extra-worth driver subassembly. Substantial attack was found in the cladding at its inside surface and the extent of this attack (up to 0.009 inch intergranular penetration at about 1150°F) correlated with temperature but not with any fuel fabrication parameter. The penetrating fission product material contained Cs, Mo, and Te. The unusually large amount of fuel/fission product/cladding reaction may be related to the high carbon content in the mixed oxides and/or to a short high temperature operating period. (12 references) (auth)

49821 FUEL-CLADDING MECHANICAL INTERACTION IN LMFBR FUEL RODS. Rubin, B. F.; Black, T. J.; Appleby, W. K.; Stephen, J. D.; Hilbert, R. F. (General Electric Co., San Jose, Calif.). Nucl. Technol.; 16: No. 1, 89-142(Oct 1972).

Experimental determinations of cladding plastic deformation in (U,Pu)O$_2$ fuel rods, clad with annealed Type 316 SS and irradiated in EBR-II, indicate that fuel-cladding mechanical interaction takes place between 3 and 8 atom % burnup. At higher burnups, the cladding swelling rate increased markedly resulting in no further fuel-induced plastic deformation. The maximum cladding plastic strain exhibited by several annealed Type 316 SS clad rods was 0.4%. Cladding plastic strain was found to be independent of smeared density in the range of 83 to 91% T.D. (15 references) (auth)

49822 PERFORMANCE OF MIXED-OXIDE FUEL ELEMENTS TO 11 AT. PERCENT BURNUP. Neimark, L. A.; Lambert, J. D. B.; Murphy, W. F.; Renfro, C. W. (Argonne National Lab., Ill.). Nucl. Technol.; 16: No. 1, 75-88(Oct 1972).

Two stainless steel-clad mixed-oxide fuel elements were examined after irradiation in EBR-II to a burnup of 11 at. %. The comparison of fuel of low oxygen-to-metal (O/M) ratio (1.94–1.97) with fuel of high O/M ratio (1.99–2.00) indicated significant differences in fuel and fission-product behavior. The lower oxidizing potential of the low O/M ratio fuel generated no attack on the Type 316L cladding. This appeared to be related to the lack of oxidation and migration of fission-product Mo to the cladding surface. Carbide precipitation in the cladding also appeared to be a factor in the type of attack that occurred. Cs, however, was mobile in both fuels. The separation of the fuel and cladding at high burnup is thought to be related to the deposition of Cs–Mo–O at the interface. In the low O/M ratio fuel, in which the Mo did not migrate to the interface, the fuel and cladding remained in contact. The diametral change in the low O/M ratio element, however, was less than in the high O/M ratio element, 3.55% compared with 4.60%. This lower deformation is attributed to greater internal swelling accommodation by the more plastic low O/M ratio fuel. The axial migration of Cs in the low O/M ratio element resulted in an apparently nondetrimental reaction with the UO$_2$ blanket and insulator pellets. (14 references) (auth)

49823 DEVELOPMENT OF CYGRO-F FOR FUEL ROD BEHAVIOR ANALYSIS. Harbourne, B. L.; Beck, M. S.; Foster, J. P.; Biancheria, A. (Westinghouse Electric Corp., Madison, Pa.). Nucl. Technol.; 16: No. 1, 156-70(Oct 1972).

An LMFBR fuel rod performance analysis system was developed using the CYGRO-F computer code. The approach used was to model materials properties and phenomena using basic data and fundamental formulations as far as possible. The uncertainties were resolved by normalizing the code against selected experimental results and making appropriate adjustments to the models. The result is an analytical system of models integrated into a central stress–strain analysis. Application of the system to independent experimental data gave satisfactory agreement between analysis and observation. Four highly significant models emerged from the work. The analytical fuel swelling model simulates volume increase saturation and subsequent volume conservate growth which can result in center hole growth independent of pore migration. The feasibility of a fundamental fuel swelling model was demonstrated. This model describes the nucleation, growth and migration of gas bubbles and produces mechanical effects similar to those in the analytical model. The cladding swelling model accounts for the effects of stress on swelling rate to reproduce the large volume changes observed in some fuel rod cladding. The results of this model are in qualitative agreement with fundamental analyses of the effect. Studies of startup and early life behavior resulted in a thermo-mechanical analysis system which describes in detail the complex interacting phenomena occurring under these transient conditions. The system may be applied to the determination of LMFBR core limiting operating conditions. (27 references) (auth)

Auxiliary Systems and Engineered Safeguards

49824 (ANCR-1049) EFFECT OF GEOMETRY AND OTHER PARAMETERS ON BOTTOM FLOODING HEAT TRANSFER ASSOCIATED WITH NUCLEAR FUEL BUNDLE SIMULATORS. McConnell, J. W. (Aerojet Nuclear Co., Idaho Falls, Idaho). Apr 1972. Contract AT(10-1)-1375. 225p. Dep. NTIS.

Full-length emergency cooling heat transfer (FLECHT) experiments have been performed on boiling water reactor (BWR) and pressurized water reactor (PWR) fuel bundle simulators. These bundle simulators, using resistance heaters electrically powered to simulate nuclear decay heat, were employed in typical reactor geometries to obtain experimental data over a wide range of test parameters. These data can be used to evaluate analytical methods used for calculating the heat transfer capabilities of reactor emergency cooling systems under simulated loss-of-coolant accident conditions. One type of emergency cooling system common to both BWR and PWR reactors which the FLECHT projects investigated is the bottom flooding system. The relationship between the heat transfer results of bottom flooding tests from the two FLECHT projects is discussed. The results of 11 BWR-FLECHT and 25 PWR-FLECHT bottom flooding tests are presented in the form of transient heat transfer coefficients at different axial and radial locations. Selected data from thermocouples embedded in the cladding and from which these coefficients were calculated are also included. 30 references. (auth)

49825 (RDT-C-14-2-T(5-72)) AREA RADIATION MONITORING SYSTEM. (Division of Reactor Development and Technology (AEC), Washington, D. C.). May 1972. 30p. RSO.

The standard establishes the basic requirements for design, fabrication, cleaning, handling, testing, calibration, marking, packaging, shipping and quality assurance for the area radiation monitoring system used in the Plant Protection System (PPS) of a nuclear reactor facility. The area radiation monitoring system described is limited to those systems which utilize pulse type counting methods in their operation and logarithmic meter scales for readout. (auth)

Operation and Economics

49826 (PEL-206) DESCRIPTION OF COMPUTER CODE PELINOMIC III. Tremeer, G. E. B. (Atomic Energy Board, Pelindaba, Pretoria (South Africa)). Nov 1971. 38p. Dep. NTIS (U. S. Sales Only).

PELINOMIC-III is a Fortran IV computer program designed to assist in the long-term planning of power supply expansion schemes. Proposed extensions to an existing system are analyzed by simulated "order-of-merit" load dispatching in which the load factors of individual stations are calculated from incremental running costs (used to arrange the stations in order) and a "load-duration" curve supplied in the input data. The availability of stations, which may vary with the age of the plant, is provided as an input to the program and is taken into account in the determination of load factors. The present-worth technique is used to obtain total discounted costs for the whole system operated over a number of years. The variation of capital, maintenance and fuel costs with time for each plant type are specified in the input data. The program permits the installation of up to four new blocks of generating capacity per annum, comprising hydro-electric, fossil-fueled or nuclear plant (converters and breeders). The program can be run in one of two modes: either the "fixed mode", in which the installation pattern is specified in the input data; or the "optimization mode", in which the most economical plant type for each increment in capacity is found by calculating discounted system costs for each of the alternatives over a number of years. An analysis of plant retirement is included in the study. An important feature of the program is its ability to take into account the economics of long distance power transmission using up to five load supply centres. The results are presented in the form of annual summaries covering the nature and location of the plant to be installed, the capital, maintenance and fuel costs for fossil and nuclear plant, the number of transmission lines required and their capital costs, total discounted system costs, foreign exchange and fuel requirements and plutonium production. 5 references. (auth)

49827 (TID-26071) NUCLEAR FUEL CYCLES: A SUMMARY REVIEW. Wymer, R. G. (Oak Ridge National Lab., Tenn.). [1971]. 38p. Dep. NTIS.

The major aspects of the nuclear fuel cycle are described. Future developments and requirements for the nuclear fuel cycle are discussed. Topics discussed include: source materials, uranium enrichment, reactor requirements, plutonium recycle, fuel reprocessing, fuel refabrication, and safety aspects. (D.C.C.)

Safety and Siting

Refer also to abstracts 48069 and 50019.

49828 (AI-AEC-13026) LMFBR SAFETY PROGRAMS. Quarterly Technical Progress Report, January-March 1972. (Atomics International, Canoga Park, Calif.). 31 May 1972. Contract AT(04-3)-824. 29p. Dep. NTIS.

LIQUID METAL FAST BREEDER REACTOR—safety programs during January to March 1972
—coolant pipe rupture in, characteristics of sodium jet discharge from, (E/T)
—coolant combustion accidents in, energy release from sodium, (E/T)
—fuel vaporization accidents in, aerosol characteristics for uranium oxide (UO_2), (E)
SODIUM—combustion in liquid metal cooled reactor accidents, energy release from, (E/T)
—flow characteristics during liquid metal cooled reactor coolant pipe rupture accidents, (E/T)
URANIUM OXIDES UO_2—vaporization in sodium cooled reactor accidents, aerosol characteristics from, (E) (D.C.C.)

49829 (ANCR-1050) EXPERIMENT DESCRIPTION AND HAZARDS EVALUATION FOR THE IRRADIATION OF FBR PHYSICS CONSTANTS SAMPLES IN THE EBR-II. Nisle, Robert G. (Aerojet Nuclear Co., Idaho Falls, Idaho). May 1972. Contract AT(10-1)-1375. 29p. Dep. NTIS.

The purpose of the experiment is to measure reactivity changes in mixed-oxide fuels as a result of irradiation in a typical fast neutron spectrum. Representative samples of such fuels were obtained and the EBR-II was used as the irradiation source because its flux spectrum resembled closely that of some fast breeder reactor concepts and was similar to the spectrum of the Coupled Fast Reactivity Measurement Facility in which the reactivity changes were to be measured. The irradiation samples are described and the hazards evaluation required for such irradiations is documented. (auth)

49830 (ANL-7909) TRANSIENT-BOILING HEAT TRANSFER FROM SPHERES TO SODIUM. Farahat, Mohamed M. K. (Argonne National Lab., Ill.). Jan 1972. Contract W-31-109-eng-38. 109p. Dep. NTIS.

Thesis. Submitted to Northwestern Univ., Evanston, Ill.

Transient, natural-convection pool boiling from spheres to subcooled sodium was studied. Hot tantalum spheres were submerged in sodium, and the surface temperature of the sphere was recorded, together with the pressure pulses that developed due to vapor growth and collapse. The experimental data were reduced by numerically solving the heat-conduction equation in the sphere, the end result being the boiling curves of sodium. The range of variables investigated was: sodium temperature 392 to 1607°F; sphere temperature 2785 to 4281°F; sphere diameters 1.0, 0.75, and 0.50 in.; sodium depth 3.0 and 4.5 in.; and atmospheric pressure. The investigation showed that sodium subcooling has a large effect on the transient-boiling curve. The initial sphere temperature did not have an appreciable effect on the boiling curve as long as the initial regime was film boiling. An effect of changing the sphere diameter was observed only in the film boiling region. The experimental data in the film boiling region are correlated by $h_t = h_{fb} + 0.88h_r + Kh_c(\Delta T_{sc} / \Delta T_{sat})$, where K depends on both the degree of subcooling and the sphere diameter. In the transition region, violent interaction occurred. The degree of violence reached a maximum at sodium temperature in the range from 1320 to 1570°F. Pressure pulses as high as 5.7 atm were measured 12 in. below the sphere. Nucleate-boiling data are presented in the transient-boiling curves of sodium at various experimental conditions. 83 references. (auth)

49831 (BAW-10048) MULTINODE ANALYSIS OF B AND W's 145-FUEL ASSEMBLY NUCLEAR PLANTS DURING LOSS-OF-COOLANT ACCIDENT. Parks, C. E.; Schermer, W. J.; Allen, R. J.; Shieh, K. C. (Babcock and Wilcox Co., Lynchburg, Va. (USA). Nuclear Power Generation Div.). Jun 1972. 107p.

Multinode analyses were conducted to evaluate several loss-of-coolant accidents for nuclear plants with 145 fuel assemblies. The multinode blowdown code, CRAFT, the reflooding code, REFLOOD, and the cladding heatup code, THETA 1-B, were used to perform these analyses at a core power of 2762 MW(t). Curves showing the parameters of interest are presented. Results of the analyses demonstrate that the emergency core cooling system will terminate the cladding temperature transient and limit the course of the LOCA in accordance with the AEC Interim Acceptance Criteria. (auth)

49832 (BNWL-1580) SOME CHARACTERISTICS OF POTENTIAL RADIOACTIVE RELEASES TO THE ATMOSPHERE FOLLOWING HYPOTHETICAL REACTOR ACCIDENTS. Watson, E. C.; Strenge, D. L. (Battelle Pacific Northwest Labs., Richland, Wash.). Jun 1972. Contract AT(45-1)-1830. 28p. Dep. NTIS.

No unique characteristics of reactor-produced fission products were found which could be used to determine the quantity of radionuclides released to the atmosphere following a postulated reactor accident. Although no unique characteristics are apparent, it may be feasible to measure the atmospheric release of fission products by gamma energy analysis and measurement. One method of doing this is discussed. This method relies heavily on mathematical modeling and presumes a knowledge of the gamma energy spectrum and relative activity of the noble gases as a group. (auth)

49833 (COO-2152-3) INVESTIGATION OF PRESSURE DROPS AND HEAT TRANSFER COEFFICIENTS FOR LOSS OF COOLANT EVALUATIONS. Quarterly Progress Report, Period Ending March 31, 1972. Weisman, J. (Cincinnati Univ., Ohio. Dept. of Chemical and Nuclear Engineering). 1972. Contract AT(11-1)-2152. 9p. Dep. NTIS.

The pressure drop and heat transfer phenomena of importance during a loss of coolant accident were investigated. The study is divided into three major parts: a) transient pressure drop, b) two-phase pressure drop and flow patterns, and c) transition boiling and reflooding heat transfer tests. 7 references. (auth)

49834 (GEAP–10221-10) DEFICIENT COOLING. Tenth Quarterly Progress Report, October 1–December 31, 1971. (General Electric Co., San Jose, Calif. Atomic Power Equipment Dept.). Jan 1972. Contract AT(04-3)-189. 62p. Dep. NTIS.

Steady-state CHF data, at 1000 and 800 psi and three mass fluxes, were taken for several geometric clearance configurations in a nine-rod bundle with 0.563-inch o.d., 6-foot-long, electrically heated calrods. Data, with reduced clearances of 0.060 and 0.030 inches in one of the corners, are lower than that with uniform clearance by about 10 and 20%, respectively, at 1000 psi. CHF data with a corner rod bowed, to within 0.075 and 0.030 inch from the wall, were up to 20% lower than the radially uniform geometry. Transient flow and depressurization tests are also reported for the nine-rod test bundle. The transient flow results indicate that a multirod bundle can withstand a severe loss in flow, at reduced heat fluxes, without serious temperature excursions. Initial conditions were normally restored when flow was re-established. Depressurization results showed that the nine-rod bundle could withstand pressure transients at 1000 and 800 psi (at up to 100 psi/sec) from representative initial conditions without the occurrence of CHF. CHF induced by higher initial heat fluxes and qualities, occurred several seconds after the minimum pressure was reached (i.e., after the blowdown terminated). (auth)

49835 (HEDL-TME–71-94) MECHANICAL WORK ENERGY FOR SODIUM–FUEL THERMAL INTERACTION. Padilla, A. Jr. (Hanford Engineering Development Lab., Richland, Wash.). Jun 1971. Contract AT(45-1)-2170. 125p. Dep. NTIS.

Methods for calculating the mechanical work energy in hypothetical maximum accidents for sodium-cooled fast reactors are reviewed with particular emphasis on the basis for sodium vapor explosions. Three methods for analyzing the thermal interaction of molten fuel with sodium are presented: SOCOOL-I, SOCOOL-II, and SOCOOL-IIA. SOCOOL-I utilizes a thermodynamic approach. Molten fuel and sodium are assumed to attain instantaneous thermal equilibrium. The resulting expansion of the sodium is calculated by assuming either (a) an infinite rate of heat transfer between the fuel and the sodium during the expansion or (b) no heat transfer. The properties of sodium above the critical point are obtained by use of corresponding states theory. SOCOOL-II calculates the rate of heat transfer from a spherical molten fuel particle to the sodium using an acoustic constraint. Heat transfer is assumed to be negligible once vaporization is initiated. SOCOOL-IIA determines the kinetic energy in the coolant slug above the core for adiabatic sodium expansion resulting from thermal interactions occurring at discrete arbitrary times. 29 references. (auth)

49836 (JAB–101) EARTHQUAKE ENGINEERING FOR NUCLEAR REACTOR FACILITIES. Blume, John A.; Sharpe, Roland L.; Kost, Garrison (Blume (John A.) and Associates, Engineers, San Francisco, Calif.). Mar 1972. 163p.

Presented are summaries of state-of-the-art procedures utilized by engineers and engineering geologists in the development of seismic design criteria and in the design and analysis of nuclear reactor facilities to resist earthquake-induced forces. Topics discussed are: earthquake exposure and ground motion; analysis of the reactor building; analysis of the containment system; analysis of the reactor pressure vessel and internals; analysis of equipment mounted in the reactor building; analysis of piping systems; damping; hydrodynamics; inelastic response and reserve energy considerations; and analytical procedures. 44 references. (auth)

49837 (NP–19349) LIQUID SODIUM–REACTOR FUEL INTERACTION. Ashbaugh III, Charles Edward (California Univ., Los Angeles). 1972. 76p.

Thesis.

An apparatus to melt reactor fuel materials (stainless steel, uranium metal, uranium dioxide, and uranium carbide) and drop them into liquid sodium at reactor operating temperatures of 750° to 1200°F was designed and constructed. The temperature response of the sodium and the pressure response in the quench chamber above the sodium well were measured during the interaction. Analysis and photographs of the melt fragments were made in order to correlate surface area changes due to differences in the melt size and sodium temperature. Experimental difficulties prevented the use of uranium dioxide, but data were obtained with the other materials. Experimental results were correlated with several analytical models. 13 references. (auth)

49838 (ORNL-TM–3738) ORNL NUCLEAR SAFETY RESEARCH AND DEVELOPMENT PROGRAM BIMONTHLY REPORT FOR JANUARY–FEBRUARY 1972. Cottrell, Wm. B. (Oak Ridge National Lab., Tenn.). May 1972. Contract W-7405-eng-26. 150p. Dep. NTIS.

The accomplishments during the months of January and February in the research and development program are summarized. Much of this work is in general support of water-cooled power reactor technology, including LOFT and industry programs, and reflects current safety problems, such as blowdown heat transfer studies. Several projects are also conducted in support of the high-temperature gas-cooled reactor (HTGR) and the liquid-metal fast breeder reactor (LMFBR) programs. Other major projects include experimental investigations of the attachment of nozzles to shells and the implementation of joint AEC-PVRC programs on heavy-section steel technology and nuclear piping, pumps, and valves. Seismic considerations of particular significance in nuclear plant design are evaluated in the seismic program. Several of the above projects are also directly related to another major undertaking, the AEC's standards program, which entails development of engineering safeguards and the establishment of codes and standards for government-owned or -sponsored reactor facilities. The recent activities of the NSIC and the Nuclear Safety journal in behalf of the nuclear community are also discussed. Of particular interest in both of these activities is the recent emphasis on environmental effects. (auth)

49839 (SRD–R–11) RADIOLOGICAL SIGNIFICANCE OF ^{137}Cs RELEASES FROM MARK II AND MARK III GAS-COOLED REACTORS. Beattie, J. R. (United Kingdom Atomic Energy Authority, Risley (England). Safety and Reliability Directorate). Jan 1972. 8p. Dep. NTIS (U. S. Sales Only).

Derived Working Limits for routine continuous gaseous discharge of ^{137}Cs and ^{131}I, and Emergency Reference Levels for accidental gaseous releases of the same isotopes are reviewed, and attention is drawn to the importance of gamma radiation from deposited ^{137}Cs as a hazard in both cases. For routine discharges external gamma radiation from deposited ^{137}Cs and internal radiation from ^{131}I in milk need to be considered. Probable discharge rates are estimated for Mark II and Mark III gas-cooled reactors using plausible assumptions, and it is shown that neither isotope is likely to be of serious concern as a routine gaseous effluent. For accidental releases, external gamma radiation from deposited ^{137}Cs and internal radiation from inhaled ^{131}I are important. Probable releases of ^{137}Cs and ^{131}I from a depressurization accident are estimated for Mark II and Mark III gas-cooled reactors. In the case of the Mark II reactor, ^{137}Cs and ^{131}I releases would be of roughly equal significance as hazards to health but probably neither would exceed the Emergency Reference Levels unless by a small margin. In the case of the Mark III reactor, if emergency cooling failed, the release of ^{131}I would be negligible, but ^{137}Cs evaporated from fuel sleeves and escaping to the atmosphere could exceed the Emergency Reference Level several-fold. (auth)

49840 (TID–3525(Rev.5)(Suppl.7)) REACTOR SAFETY. A Literature Search. Raleigh, Henry D. (comp.) (Technical Information Center (AEC), Oak Ridge, Tenn.). Jun 1972. 75p. Dep. NTIS.

Included are 296 citations to references issued during 1971 on safety aspects of nuclear reactor design, siting, materials, engineered safeguards, and operating procedures. Reports cited concern hazards analyses of entire facilities to satisfy construction and operation permit requirements, evaluation of the reliability of reactor systems and components, and analyses of the consequences of potential accident conditions. Subject, author, corporate author, and report number-availability indexes are included. (auth)

49841 (WCAP–7950) FUEL ASSEMBLY SAFETY ANALYSIS FOR COMBINED SEISMIC AND LOSS-OF-COOLANT ACCIDENT. Gesinski, L. T. (Westinghouse Electric Corp., Pittsburgh, Pa.). Jul 1972. 40p.

In the event that a seismic disturbance results in a simultaneous reactor blowdown accident, the fuel assembly component stresses are caused by the combined forces. As a consequence, a two-dimensional fuel assembly structural model which describes the fuel assembly internal force and stress distribution under both lateral and axial loads was developed to study this condition. This model was formulated into an equivalent finite element computer model for computation by a general structural code. A description of the fuel assembly model and analysis is presented. Experimental work performed to verify the analytical model and obtain fuel assembly experimental information, such as impact forces and damping constants, from fuel assembly axial impact tests is reported. The analytical model and experiment information was then used in the stress analysis of the fuel assembly under the combined effects of seismic and blowdown forces. Although the model structural analysis is applicable to any general Rod Cluster Control (RCC) fuel assembly, the combined seismic and blowdown analysis is restricted to the Diablo Canyon fuel assemblies since it represents the initial high seismic (0.4 g) plant design. (auth)

Steam and Power Conversion System

Refer also to abstract 47974.

49842 (JPRS–56350) OPTIMIZATION OF THE SECONDARY SECTIONS OF WATER-COOLED NUCLEAR POWER PLANTS. Popyrin, L. S.; Naumov, Yu. V. Translated from Izv. Akad. Nauk SSSR, Energ. Transp.; No. 2, 140-9(1972). 13p. Dep. NTIS.

The insufficiency of studies performed earlier on the optimization of the secondary section of a nuclear power plant with water-cooled reactors is demonstrated. A description is presented of a mathematical model of the object being studied. A new method is suggested for modeling the technological plan. Analysis is presented of the influence of individual factors and parameters on the thermal economy of the secondary section of a nuclear power plant. Thermodynamic optimization of parameters and characteristics of an installation is performed with various estimates of losses due to humidity and the effectiveness of moisture removal. 10 references. (JPRS)

Commercial Power Reactors

Refer also to abstract 47945.

Physics and Core Engineering

49843 (GULF-GA-A–12030) PUBLIC SERVICE COMPANY OF COLORADO 330-MW(E) HIGH-TEMPERATURE GAS-COOLED REACTOR RESEARCH AND DEVELOPMENT PROGRAM. Quarterly Progress Report for the Period Ending March 31, 1972. (Gulf General Atomic Co., San Diego, Calif.). 28 Apr 1972. Contract AT(04-3)-633. 39p. Dep. NTIS.

Work reported here includes studies of component development, such as auxiliary equipment and special tools, and nuclear analysis of the fuel cycle, fuel zoning, and power shaping for the 330-MW(e) High-temperature Gas-cooled Reactor. Demonstration testing of the performance of test fuel elements by means of irradiation at expected operating temperatures and capsule irradiation tests of production fuel is described. Studies covering the components of the steam generator under operating conditions are included. Experimental procedures and results are discussed and, where appropriate, the data are presented in tables, graphs, and photographs. More detailed descriptions of experimental work are presented in topical reports, and these are listed at the end of the report for those concerned with the field. (auth)

49844 (WCAP–7718) WESTINGHOUSE PWR INTERNALS VIBRATION SUMMARY 2-LOOP INTERNALS ASSURANCE. Kuenzel, A. J. (Westinghouse Electric Corp., Pittsburgh, Pa.). Feb 1972. 28p. Dep. NTIS.

The dynamic behavior of reactor components is studied using experimental data obtained from reactors in operation, results of model tests, and static and dynamic tests conducted in the shop and at the plant site. Analytical techniques have been developed to study the structures mathematically and to predict the behavior of components. An extensive instrumentation program to measure vibration of reactor internals included the prototype unit of each size reactor, i.e., R. E. Ginna (RGE), H. B. Robinson (CPL) and Indian Point Unit 2 (IPP). The bases used to formulate the instrumentation program for the standard 2-Loop plant (STD-2) are described. The similarities between STD-2 and RGE and the differences between those plants and SELNI/SENA/Yankee-Rowe are discussed. (auth)

Control and Instrumentation

49845 (ANL–7874) MAGNETOMETER FLOWSENSOR. Wiegand, D. E. (Argonne National Lab., Ill.). Mar 1972. Contract W-31-109-eng-38. 84p. Dep. NTIS.

The magnetometer flowsensor is a stream-immersed device that measures the velocity of a liquid-metal coolant in its vicinity. A small sensor size, typically $^{3}/_{8}$-in. OD in an encapsulated sealed version, adapts it well to flow measurements in liquid-metal fast breeder reactors, where disturbances of the flow and reactivity conditions by the sensor should be minimal. Other advantages are high signal levels (typically 600-mV open loop at normal flow conditions), a flow calibration based on simple electromagnetic measurements, and the use of a feedback system that eliminates the effects of the major sources of temperature, radiation, and aging changes. An added dividend of the simple geometry of the sensor is the adaptability to computerized calculations, which provide performance characteristics based on measured values of the magnet moments, the field-to-current ratio of the feedback coil (actually the fluxgate secondary), and the dimensions of the configuration. (25 references) (auth)

49846 (DOCKET-50029–191) YANKEE NUCLEAR POWER STATION. Control Rod Drop Data. (Yankee Atomic Electric Co., Westboro, Mass.). 7 Aug 1972. 3p. Dep. NTIS.

Containment Systems, Waste Processing, and Radiation Protection

49847 (DOCKET-50133–90) HUMBOLDT BAY POWER PLANT, UNIT 3. Technical Specifications, Proposed Change 41. (Pacific Gas and Electric Co., San Francisco, Calif.). 8 Aug 1972. 13p. Dep. NTIS.

A proposal is presented for the design, test, and operation of a modified off-gas system to be installed at the Humboldt Bay Power Reactor. (H.D.R.)

Coolant System

Refer also to abstracts 47849 and 48358–48360.

49848 (DOCKET-50346–31) DAVIS–BESSE NUCLEAR POWER STATION. Shipment Damage to Primary Coolant Pump Casing S/N 701-N-0241. (Directorate of Regulatory Operations (AEC), Washington, D. C.). 4 Aug 1972. 4p. Dep. NTIS.

49849 ENVIRONMENTAL PROBLEMS ASSOCIATED WITH THE REPAIR OF A NUCLEAR POWER REACTOR PRIMARY COOLANT SYSTEM. Long, Robert L. (Univ. of New Mexico, Albuquerque); Liebler, George L. pp 388-92 of Institute of Environmental Sciences 1972 Proceedings. Environmental Progress in Science and Education. Mt. Prospect, Ill.; Inst. of Environmental Sciences (1972).

From eighteenth annual meeting on environmental progress in science and education; New York, NY. (1 May 1972). See CONF-720511.

Maintenance procedures and radiation protection requirements used in repairing the Indian Point Power Reactor Unit 1 cooling system are described. (D.C.C.)

Fuels and Fuel Elements

Refer also to abstract 48353.

49850 (GULF-GA-A–10980) PUBLIC SERVICE COMPANY OF COLORADO 330-MW(e) HIGH-TEMPERATURE GAS-COOLED REACTOR RESEARCH AND DEVELOPMENT PROGRAM. Quarterly Progress Report for the Period Ending December 31, 1971. (Gulf General Atomic Co., San Diego, Calif.). 31 Jan 1972. Contract AT(04-3)-633. 75p. Dep. NTIS.

The research and development program for the Public Service Company of Colorado 330-MW(e) High-temperature Gas-cooled Reactor is reviewed. The review includes studies of component development, such as auxiliary equipment and special tools, and nuclear analysis of the fuel cycle, fuel zoning, and power shaping. The fuel development program and fuel element proof testing include demonstration testing of the performance of test fuel elements by means of irradiation at expected operating temperatures and capsule irradiation tests of production fuel. Studies covering the components of the steam generator under operating conditions are included. Experimental procedure and results are discussed and, where appropriate, the data are presented in tables, graphs, and photographs. (auth)

Auxiliary Systems and Engineered Safeguards

49851 (WCAP–7829) FAN COOLER MOTOR UNIT TEST. Fields, C. V. (Westinghouse Electric Corp., Pittsburgh, Pa.). Apr 1972. 111p.

Tests reported in 1969 demonstrated the effectiveness of a heat exchanger assembly in isolating motor windings from the steam and chemistry environments of a post design basis event in a nuclear reactor containment. Subsequent tests have established long-term bearing life of such a motor and the radiation resistance of the windings. Additional steam exposure tests are now reported to comply with all provisions of the Guide for Type Tests of Class 1 Motors Installed Inside the Containment of Nuclear Power Generating Stations, IEEE Guide 334. Also, these tests qualified design features not included in the original motor. Steam exposure tests of IEEE 334 were also performed on the same motor without the heat exchanger to qualify the motor for short-term, postevent operation. The Guide makes no provision for extrapolation to long-term postevent service and neither prescribed tests nor others conducted to this date are considered adequate to insure long-term, postaccident service without benefit of a heat exchanger. 5 references. (auth)

Operation and Economics

49852 (DOCKET-50003-121) INDIAN POINT STATION, UNITS 1 AND 2. Loss of Off-Site Power on July 20, 1972. (Consolidated Edison Co. of New York, Inc., New York). 18 Aug 1972. 3p. (DOCKET-50247-79). Dep. NTIS.
From seventeenth congress ampere: nuclear magnetic resonance and related phenomena, Turku, Finland (21 Aug 1972).

49853 (DOCKET-50003-122) INDIAN POINT STATION, UNIT 1. Unscheduled Release of Air-Borne Radioactivity on July 23, 1972. (Consolidated Edison Co. of New York, Inc., New York). 21 Aug 1972. 2p. Dep. NTIS.

49854 (DOCKET-50010-115) DRESDEN NUCLEAR POWER STATION, UNIT 1. Annual Report of Station Operation for 1971, Revisions. (Commonwealth Edison Co., Chicago, Ill.). 14 Aug 1972. 5p. Dep. NTIS.

49855 (DOCKET-50016-166) ENRICO FERMI ATOMIC POWER PLANT, UNIT 1. Results of the Examination of Subassembly L-174F. (Power Reactor Development Co., Detroit, Mich.). 14 Aug 1972. 26p. Dep. NTIS.

49856 (DOCKET-50133-92) HUMBOLDT BAY POWER PLANT, UNIT 3. Technical Specifications, Change 39. (Directorate of Licensing (AEC), Washington, D. C.). 26 Jul 1972. 8p. Dep. NTIS.
Revised technical specifications are presented concerning the use of Type 3-4 GE fuel assemblies during Cycle 8 operations. (D.C.C.)

49857 (DOCKET-50133-93) HUMBOLDT BAY POWER PLANT, UNIT 3. Need for Change in Indicating Light Circuit. (Pacific Gas and Electric Co., San Francisco, Calif.). 14 Aug 1972. 3p. Dep. NTIS.

49858 (DOCKET-50133-94) HUMBOLDT BAY POWER PLANT, UNIT 3. Operation Report, January 1-June 30, 1972. (Pacific Gas and Electric Co., San Francisco, Calif.). 16 Aug 1972. 18p. Dep. NTIS.

49859 (DOCKET-50206-165) SAN ONOFRE NUCLEAR GENERATING STATION, UNIT 1. Operating License, Amendment 26. (Southern California Edison Co., Rosemead, Calif.). 14 Aug 1972. 92p. Dep. NTIS.
Estimated operating costs for the San Onofre Power Reactor Unit 1 are presented. The 1971 Annual Reports for the Southern California Edison Company and the San Diego Gas and Electric Company are included. (D.C.C.)

49860 (DOCKET-50219-205) OYSTER CREEK NUCLEAR POWER PLANT, UNIT 1. Safety Valve Seat Bushing Cracks. (Jersey Central Power and Light Co., Morristown, N. J.). 11 Aug 1972. 11p. Dep. NTIS.

49861 (DOCKET-50219-206) OYSTER CREEK NUCLEAR POWER PLANT, UNIT 1. Quarterly Personnel Exposures. (Directorate of Regulatory Operations (AEC), Washington, D. C.). 24 Aug 1972. 4p. Dep. NTIS.

49862 (DOCKET-50219-207) OYSTER CREEK NUCLEAR POWER PLANT, UNIT 1. Inoperability of Isolation Condensers. (Jersey Central Power and Light Co., Morristown, N. J.). 22 Aug 1972. 2p. Dep. NTIS.

49863 (DOCKET-50237-256) DRESDEN NUCLEAR POWER STATION, UNITS 2 AND 3. Primary System Isolation from Reactor Vessel High Water Level. (Commonwealth Edison Co., Chicago, Ill.). 18 Aug 1972. 2p. (DOCKET-50249-152). Dep. NTIS.

49864 (DOCKET-50244-113) ROBERT EMMETT GINNA NUCLEAR POWER PLANT, UNIT 1. Power Escalation to 1520 MWt, March 1972. (Rochester Gas and Electric Corp., N. Y.). 14 Aug 1972. 37p. Dep. NTIS.

49865 (DOCKET-50245-147) MILLSTONE POINT NUCLEAR POWER STATION, UNIT 1. Technical Specifications, Change 5. (Directorate of Licensing (AEC), Washington, D. C.). 31 Jul 1972. 3p. Dep. NTIS.
Revised technical specifications are presented concerning temporary changes in surveillance requirements for the automatic pressure relief system during sensor installation procedures for the gas turbine generator. (D.C.C.)

49866 (DOCKET-50245-150) MILLSTONE POINT NUCLEAR POWER STATION, UNIT 1. Abnormal Occurrence No. AO-72-19. (Millstone Point Co., Hartford, Conn.). 11 Aug 1972. 1p. Dep. NTIS.
Information is presented concerning the incorrect trip level for the protection system low-low level switch. (D.C.C.)

49867 (DOCKET-50245-151) MILLSTONE POINT NUCLEAR POWER STATION, UNIT 1. Set Point for Emergency Diesel Found to be Low. (Millstone Point Co., Hartford, Conn.). 9 Aug 1972. 1p. Dep. NTIS.

49868 (DOCKET-50254-113) QUAD-CITIES STATION, UNITS 1 AND 2. Facility Operating License DPR-29, Amendment 4 and Facility Operating License DPR-30, Amendment 2. (Directorate of Licensing (AEC), Washington, D. C.). 15 Aug 1972. 10p. (DOCKET-50265-102). Dep. NTIS.
Authorization for operation of the reactors to power levels up to 2260 MW(t) each with the diffuser-pipe system in operation is presented. Extension of the operating license expiration date is included. (D.C.C.)

49869 (DOCKET-50254-116) QUAD-CITIES STATION, UNITS 1 AND 2. Error in Placement of an Electrical Jumper. (Commonwealth Edison Co., Chicago, Ill.). 15 Aug 1972. 3p. (DOCKET-50265-105). Dep. NTIS.

49870 (DOCKET-50261-103) H. B. ROBINSON UNIT 2. Results of Analysis for Radioisotopes. (Directorate of Regulatory Operations (AEC), Atlanta, Ga. (USA). Region II). 22 Aug 1972. 3p. Dep. NTIS.

49871 (DOCKET-50265-106) QUAD-CITIES STATION, UNIT 2. Abnormal Flow Indication on Jet Pump. (Commonwealth Edison Co., Cordova, Ill.). 21 Aug 1972. 1p. Dep. NTIS.

49872 (DOCKET-50265-107) QUAD-CITIES STATION, UNIT 2. Failure of Timer 2-1705-23 in the Off-Gas System. (Commonwealth Edison Co., Cordova, Ill.). 17 Aug 1972. 2p. Dep. NTIS.

49873 (DOCKET-50266-76) POINT BEACH NUCLEAR PLANT, UNITS 1 AND 2. Failure of Circuit Breaker Overcurrent Trip Delay Device. (Wisconsin Electric Power Co., Milwaukee). 16 Aug 1972. 2p. (DOCKET-50301-67). Dep. NTIS.

49874 (DOCKET-50269-62) OCONEE NUCLEAR STATION, UNIT 1. Technical Specifications, Acceptable Changes. (Directorate of Licensing (AEC), Washington, D. C.). 28 Aug 1972. 4p. Dep. NTIS.

49875 (DOCKET-50271-96) VERMONT YANKEE NUCLEAR POWER STATION. Operations Report No. 72-6 for Month of June 1972. (Vermont Yankee Nuclear Power Corp., Rutland). 17 Aug 1972. 24p. Dep. NTIS.

49876 (DOCKET-50277-53) PEACH BOTTOM ATOMIC POWER STATION, UNITS 2 AND 3. Estimated Operating and Permanent Shutdown Costs. (Philadelphia Electric Co., Pa.). 10 Aug 1972. 4p. (DOCKET-50278-53). Dep. NTIS.

49877 (DOCKET-50289-65) THREE MILE ISLAND NUCLEAR STATION, UNIT 1. Report on Containment Building Ring Girder Construction and Repair, Addendum 3. (Metropolitan Edison Co., Reading, Pa.). 22 Aug 1972. 8p. Dep. NTIS.

49878 (DOCKET-50293-84) PILGRIM NUCLEAR POWER STATION. Loss of Ten, Two Microcuries ^{60}Co Sources. (Atomic Energy Commission, Washington, D. C.). 12 Jul 1972. 3p. Dep. NTIS.

49879 (DOCKET-50293-85) PILGRIM NUCLEAR POWER STATION. Abnormal Occurrence AO-72-6. (Boston Edison Co., Mass.). 14 Aug 1972. 2p. Dep. NTIS.
Information is presented concerning the malfunction of the protection system high water level switch. (D.C.C.)

49880 (DOCKET-50309-67) MAINE YANKEE ATOMIC POWER STATION. Interim Report on Guide Vane Failure. (Directorate of Regulatory Operations (AEC) Washington, D. C.). 21 Aug 1972. 37p. Dep. NTIS.
Information is presented concerning the failure of a coolant pump suction guide vane. Analysis of the damage from the failed guide vane is included. (D.C.C.)

49881 (DOCKET-50317-55) CALVERT CLIFFS NUCLEAR POWER PLANT, UNITS 1 AND 2. License Application. Amendment 24. (Baltimore Gas and Electric Co., Md.). 18 Aug 1972. 118p. (DOCKET-50318-53). Dep. NTIS.

Financial data on the owners of the Calvert Cliffs Power Reactor Units 1 and 2 are presented. The 1969, 1970, and 1971 Annual Reports of the Baltimore Gas and Electric Company are included. (D.C.C.)

49882 (DOCKET-50390-21) WATTS BAR NUCLEAR PLANT, UNITS 1 AND 2. Application for Construction Permits, Amendment 14. (Tennessee Valley Authority, Chattanooga). 22 Aug 1972. 3p. (DOCKET-50391-21). Dep. NTIS.

Additional information is presented concerning the construction and initial operation costs for the Watts Bar Power Reactor Units 1 and 2. (D.C.C.)

49883 (DOCKET-50395-27) VIRGIL C. SUMMER NUCLEAR STATION, UNIT 1. Application for Licenses, Amendment 15. (South Carolina Electric and Gas Co., Columbia). 25 Aug 1972. 72p. Dep. NTIS.

Estimated operating costs for the Virgil C. Summer Power Reactor Unit 1 are presented. The 1971 Annual Report and the June 1972 Quarterly Report for the South Carolina Electric and Gas Company are included. (D.C.C.)

49884 (TID-26084) ARDENNES NUCLEAR POWER PLANT. Monthly Report, December 1971. (Societe d'Energie Nucleaire Franco-Belge des Ardennes, Chooz-lez-Givet (France)). 1971. 18p. Dep. NTIS.

Operation of the plant at full power was disturbed by a hot shutdown on 9 December for the replacement of the pre-exciter brushes. Since this did not eliminate the arcing at the commutator, a second shutdown was planned on the same day for the replacement of the pre-exciter rotor. Restarting was delayed by the settings of the new inductor in this device and by the malfunctioning of a turbine trip unit, causing the spurious closing of the shutdown valves during the run up to load. Monthly operating statistics include: 687 hours operating time; 186,000 MWh net production; 92.6% availability. (auth)

49885 (TID-26085) ARDENNES NUCLEAR POWER PLANT. Monthly Report for January 1972. (Societe d'Energie Nucleaire Franco-Belge des Ardennes, Chooz-lez-Givet (France)). 1972. 17p. Dep. NTIS.

The plant remained phased to line at nominal power throughout the month. On three occasions short-duration load shedding was necessary in order to facilitate investigations into the ingress of raw water into the condenser. On 31 January the plant had logged 51 days of uninterrupted operation. Monthly operating statistics include: 744 hours operating time; 203,500 MWh net production; and 101.28% availability based on a net contractual power of 270 MW(e). (auth)

Safety and Siting

Refer also to abstract 48074.

49886 (CONF-710644) PROCEEDINGS OF THE CONFERENCE ON NUCLEAR ENERGY AND THE ENVIRONMENT, DREXEL UNIVERSITY, JUNE 21-25, 1971. (Franklin Inst. Research Labs., Philadelphia, Pa.). 133p.

The collection of papers includes some AEC news releases on atomic energy, papers on the historical development of U. S. nuclear energy program, breeder reactor development, a generalized study of nuclear power plant design, gamma radiation shielding studies, environmental effects of low level radiation discharges, and water quality criteria. Also included are a glossary of terms, projected world population curves, projected energy consumption curves, maps of steam generating centers, and curves and charts of non-nuclear fuel reserves and energy production and consumption. (J.M.J.)

49887 (DOCKET-50010-116) DRESDEN NUCLEAR POWER STATION, UNIT 1. Supplement G to Proposed Change 17 to DPR-2, as Amended. (Commonwealth Edison Co., Chicago, Ill.). 23 Aug 1972. 9p. Dep. NTIS.

Requested additional information is presented concerning maximum control rod worths, valves for the emergency steam condenser and core spray isolation system, primary cooling system and containment system accident instrumentation, and earthquake stress requirements for the fire protection system. (D.C.C.)

49888 (DOCKET-50219-208) OYSTER CREEK NUCLEAR POWER PLANT, UNIT 1. Safety and Relief Valve Piping Design Report. (Jersey Central Power and Light Co., Morristown, N. J.). 22 Aug 1972. 31p. Dep. NTIS.

49889 (DOCKET-50244-110) ROBERT EMMETT GINNA NUCLEAR POWER PLANT, UNIT 1. Environmental Report, Volume 1. (Rochester Gas and Electric Corp., N. Y.). 15 Aug 1972. 446p. Dep. NTIS.

Information concerning radioactive and thermal discharges from the reactor is presented. The effects of reactor operations on the environment are analyzed. Hydrological and meteorological data for the reactor site are included. Cost-benefit analysis for reactor operations is presented. (D.C.C.)

49890 (DOCKET-50244-111) ROBERT EMMETT GINNA NUCLEAR POWER PLANT, UNIT 1. Environmental Report, Volume 2. (Rochester Gas and Electric Corp., N. Y.). Aug 1972. 647p. Dep. NTIS.

Information concerning radioactive and thermal discharges from the reactor is presented. The effects of reactor operations on the environment are analyzed. Ecological, geological, hydrological, and limnological data on the reactor site are included. (D.C.C.)

49891 (DOCKET-50244-112) ROBERT EMMETT GINNA NUCLEAR POWER PLANT, UNIT 1. Application to Correct Provisional Operating License. (Rochester Gas and Electric Corp., N. Y.). 15 Aug 1972. 202p. Dep. NTIS.

Supplemental financial and technical information is presented concerning the application for a full-term operating license. (D.C.C.)

49892 (DOCKET-50244-114) ROBERT EMMETT GINNA NUCLEAR POWER PLANT, UNIT 1. Response to Questions Asked on June 16 and June 23, 1972. (Rochester Gas and Electric Corp., N. Y.). 21 Aug 1972. 16p. Dep. NTIS.

Requested additional information is presented concerning fuel rod performance. (D.C.C.)

49893 (DOCKET-50245-148) MILLSTONE POINT NUCLEAR POWER STATION, UNIT 1. First Reload License Submitted. (Millstone Point Co., Hartford, Conn.). 15 Aug 1972. 40p. Dep. NTIS.

49894 (DOCKET-50245-149) MILLSTONE POINT NUCLEAR POWER STATION, UNIT 1. Technical Specifications, Proposed Change. (Millstone Point Co., Hartford, Conn.). 14 Aug 1972. 32p. Dep. NTIS.

Revised information is presented concerning transient analysis for reactor scrams based on end of cycle conditions. (D.C.C.)

49895 (DOCKET-50245-152) MILLSTONE POINT NUCLEAR POWER STATION, UNIT 1. Report of Personnel Exposure to Radiation of July 24, 1972. (Directorate of Regulatory Operations (AEC), Washington, D. C.). 21 Aug 1972. 4p. (DOCKET-50336-39). Dep. NTIS.

The exposure of six workmen to γ radiation during the excavation for foundations for a main transformer sound isolation wall is described. The estimated whole body exposures for the workmen are listed. Safety procedures for future construction activities are presented. (D.C.C.)

49896 (DOCKET-50247-78) INDIAN POINT NUCLEAR GENERATING UNIT 2. Summary Report of Fuel Rod Anomalies and Their Impact on the Operation During 50 Percent Testing Operations. (Consolidated Edison Co. of New York, Inc., New York). 17 Aug 1972. 5p. Dep. NTIS.

49897 (DOCKET-50249-153) DRESDEN NUCLEAR POWER STATION, UNIT 3. Special Report 16, Fuel Inspection and Evaluation, Corrections. (Commonwealth Edison Co., Chicago, Ill.). 18 Aug 1972. 1p. Dep. NTIS.

49898 (DOCKET-50250-87) TURKEY POINT PLANT, UNITS 3 AND 4. Final Safety Analysis Report, Supplement 51. (Florida Power and Light Co.). 4 Aug 1972. 57p. (DOCKET-50251-74). Dep. NTIS.

The final safety analysis report for the Turkey Point Power Reactor Units 3 and 4 is supplemented by the submission of revised and additional safety information. (D.C.C.)

49899 (DOCKET-50254-114) QUAD-CITIES STATION, UNITS 1 AND 2. Technical Specifications, Change 3. (Directorate of Licensing (AEC), Washington, D. C.). 15 Aug 1972. 252p. (DOCKET-50265-103). Dep. NTIS.

49900 (DOCKET-50254-115) QUAD-CITIES STATION, UNITS 1 AND 2. Discussion and Conclusions of Environmental Impact. (Directorate of Licensing (AEC), Washington, D. C.). Aug 1972. 10p. (DOCKET-50265-104). Dep. NTIS.

Information concerning chemical, radioactive, and thermal discharges from the reactors is presented. The effects of reactor operations on the environment are analyzed. (D.C.C.)

49901 (DOCKET-50259-61) BROWNS FERRY NUCLEAR POWER STATION, UNITS 1, 2, AND 3. Environmental Radioactivity Levels, Semiannual Report, July–December 1971. (Tennessee Valley Authority, Chattanooga. Div. of Environmental Research and Development). 17 Aug 1972. 34p. (DOCKET-50260-57; DOCKET-50296-54). Dep. NTIS.

49902 (DOCKET-50259-62) BROWNS FERRY NUCLEAR POWER STATION, UNITS 1, 2, AND 3. Final Safety Analysis Report, Amendment 39. (Tennessee Valley Authority, Chattanooga). 15 Aug 1972. 37p. (DOCKET-50260-58; DOCKET-50296-55). Dep. NTIS.

The final safety analysis report for the Browns Ferry Power Reactor Units 1, 2, and 3 is amended by the submission of revised and requested safety information. (D.C.C.)

49903 (DOCKET-50259-63) BROWNS FERRY NUCLEAR POWER STATION, UNITS 1, 2, AND 3. Final Safety Analysis Report, Amendment 40. (Tennessee Valley Authority, Chattanooga). 22 Aug 1972. 65p. (DOCKET-50260-59; DOCKET-50296-56). Dep. NTIS.

The final safety analysis report for the Browns Ferry Power Reactor Units 1, 2, and 3 is amended by the submission of revised and requested safety information. (D.C.C.)

49904 (DOCKET-50263-144) MONTICELLO NUCLEAR GENERATING PLANT, UNIT 1. Change in the Transient Analysis as Described in the FSAR. (Northern States Power Co., Minneapolis, Minn.). 14 Aug 1972. 1p. Dep. NTIS.

Revised information is presented concerning transient analysis for reactor scrams based on end of cycle conditions. (D.C.C.)

49905 (DOCKET-50275-24) DIABLO CANYON NUCLEAR POWER PLANT, UNITS 1 AND 2. Environmental Report, Supplement 2, Clarification. (Pacific Gas and Electric Co., San Francisco, Calif.). 22 Aug 1972. 2p. (DOCKET-50323-22). Dep. NTIS.

Additional information is presented concerning the thermal effluents from the reactors and the configuration of the cooling water discharge pipe. (D.C.C.)

49906 (DOCKET-50277-54) PEACH BOTTOM ATOMIC POWER STATION, UNITS 2 AND 3. Flood Damage to Equipment in Warehouse at Middletown, Pennsylvania. (Directorate of Licensing (AEC), Washington, D. C.). 22 Aug 1972. 5p. (DOCKET-50278-54). Dep. NTIS.

49907 (DOCKET-50280-79) SURRY POWER STATION, UNIT 1. Technical Specifications, Change Request. (Virginia Electric and Power Co., Richmond). 16 Aug 1972. 2p. Dep. NTIS.

Revised technical specifications are presented concerning the containment spray subsystems. (D.C.C.)

49908 (DOCKET-50280-80) SURRY POWER STATION, UNITS 1 AND 2. Proposal to Employ a Catalytic Hydrogen Recombiner to Control Buildup of Hydrogen. (Virginia Electric and Power Co., Richmond). 18 Aug 1972. 2p. (DOCKET-50281-76). Dep. NTIS.

49909 (DOCKET-50280-81) SURRY POWER STATION, UNITS 1 AND 2. Technical Specifications, Change 1. (Directorate of Licensing (AEC), Washington, D. C.). 18 Aug 1972. 6p. Dep. NTIS.

Revised technical specifications are presented concerning the operation of the Surry Power Reactor Unit 1 with the turbine drives for the containment spray pumps out of service. (D.C.C.)

49910 (DOCKET-50286-50) INDIAN POINT NUCLEAR GENERATING UNIT 3. Order Extending the Construction Completion Data From September 1, 1972 to March 1, 1974. (Directorate of Licensing (AEC), Washington, D. C.). 14 Aug 1972. 2p. Dep. NTIS.

49911 (DOCKET-50286-51) INDIAN POINT NUCLEAR GENERATING UNIT 3. Final Facility Description and Safety Analysis Report, Supplement 8. (Consolidated Edison Co. of New York, Inc., New York). 25 Aug 1972. 170p. Dep. NTIS.

Revised and requested data are presented concerning the containment system, auxiliary and emergency systems, and power conversion system. (D.C.C.)

49912 (DOCKET-50289-64) THREE MILE ISLAND NUCLEAR STATION, UNITS 1 AND 2. Environmental Report, Supplement 1. (Metropolitan Edison Co., Reading, Pa.). 9 Aug 1972. 84p. (DOCKET-50320-30). Dep. NTIS.

Additional information is presented concerning power transmission lines and thermal discharge characteristics of the cooling towers. (D.C.C.)

49913 (DOCKET-50312-49) RANCHO SECO NUCLEAR GENERATING STATION, UNIT 1. Final Safety Analysis Report, Amendment 14. (Sacramento Municipal Utility District, Calif.). 21 Aug 1972. 262p. Dep. NTIS.

The final safety analysis report for the Rancho Seco Power Reactor is amended by the submission of revised and requested safety information. (D.C.C.)

49914 (DOCKET-50313-47) ARKANSAS NUCLEAR ONE, UNIT 1. Final Safety Analysis Report, Amendment 28. (Arkansas Power and Light Co., Little Rock). 18 Aug 1972. 346p. Dep. NTIS.

The final safety analysis report for the Arkansas Nuclear One Power Reactor is amended by the submission of revised and requested safety information. (D.C.C.)

49915 (DOCKET-50315-72) DONALD C. COOK NUCLEAR PLANT, UNITS 1 AND 2. Final Safety Analysis Report, Amendment 27. (Indiana and Michigan Power Co., New York). 17 Aug 1972. 155p. (DOCKET-50316-72). Dep. NTIS.

The final safety analysis report for the Donald C. Cook Power Reactor Units 1 and 2 is amended by the submission of revised and requested safety information. (D.C.C.)

49916 (DOCKET-50317-54) CALVERT CLIFFS NUCLEAR POWER PLANT, UNITS 1 AND 2. Final Safety Analysis Report, Amendment 23. (Baltimore Gas and Electric Co., Md.). 15 Aug 1972. 216p. (DOCKET-50318-52). Dep. NTIS.

The final safety analysis report for the Calvert Cliffs Power Reactor Units 1 and 2 is amended by the submission of revised and additional safety information. (D.C.C.)

49917 (DOCKET-50317-56) CALVERT CLIFFS NUCLEAR POWER PLANT, UNIT 1. Interim Report Dated August 4, 1972 on Defects in Stainless Steel Pipe. (Directorate of Regulatory Operations (AEC), Washington, D. C.). 15 Aug 1972. 3p. Dep. NTIS.

49918 (DOCKET-50327-27) SEQUOYAH NUCLEAR PLANT, UNITS 1 AND 2. Failure of Ice Basket. (Directorate of Regulatory Operations (AEC), Washington, D. C.). 22 Aug 1972. 3p. (DOCKET-50328-25). Dep. NTIS.

49919 (DOCKET-50333-52) JAMES A. FITZPATRICK NUCLEAR POWER PLANT. Final Safety Analysis Report, Supplement 10. (Power Authority of the State of New York). 15 Aug 1972. 8p. Dep. NTIS.

The final safety analysis report for the James A. Fitzpatrick Power Reactor is supplemented by the submission of additional data on radioactive effluents. (D.C.C.)

49920 (DOCKET-50336-38) MILLSTONE POINT NUCLEAR POWER STATION, UNIT 2. Final Safety Analysis Report, Volume 3. (Millstone Point Co., Hartford, Conn.). 24 Oct 1969. 927p. Dep. NTIS.

Information on the Millstone Point Power Reactor Unit 2 is presented under the following broad topics: radioactive waste processing; radiation protection systems; operations aspects; emergency plan; initial tests and operations; safety analysis; and technical specifications. (D.C.C.)

49921 (DOCKET-50346-32) DAVIS–BESSE NUCLEAR POWER STATION. Hydrological Surveys for the Locust Point Power Plant. Part IV. The 1969 Phytoplankton Collections in the Locust Point Region. (Michigan Univ., Ann Arbor. Great Lakes Research Div.). Jul 1970. 44p. Dep. NTIS.

For Toledo Edison Co., Ohio.

49922 (DOCKET-50348-43) JOSEPH M. FARLEY NUCLEAR PLANT, UNITS 1 AND 2. Notice of Issuance of Construction Permits Nos. CPPR-85 and CPPR-86. (Directorate of Licensing (AEC), Washington, D. C.). 16 Aug 1972. 65p. (DOCKET-50364-37). Dep. NTIS.

49923 (DOCKET-50354-26) NEWBOLD ISLAND NUCLEAR GENERATING STATION, UNITS 1 AND 2. Environmental Report, Construction Permit Stage, Amendment 2. (Public Service Electric and Gas Co., Newark, N. J.). 21 Aug 1972. 388p. (DOCKET-50355-25). Dep. NTIS.

The environmental report for the Newbold Island Power Reactor Units 1 and 2 is amended by the submission of revised and additional information. (D.C.C.)

49924 (DOCKET-50358-38) WILLIAM H. ZIMMER NUCLEAR POWER STATION, UNIT 1. Environmental Monitoring Programs. (Cincinnati Gas and Electric Co., Ohio). 17 Aug 1972. 4p. Dep. NTIS.

49925 (DOCKET-50358-39) WILLIAM H. ZIMMER NUCLEAR POWER STATION, UNIT 1. Design Parameters for Blowdown Water Temperature. (Cincinnati Gas and Electric Co., Ohio). 22 Aug 1972. 1p. Dep. NTIS.

Additional information is presented concerning the blowdown water temperature from the natural draft cooling tower. (D.C.C.)

49926 (DOCKET-50363-33) FORKED RIVER NUCLEAR GENERATING STATION, UNIT 1. Notice of Hearing on Application for Construction Permit. (Directorate of Licensing (AEC), Washington, D. C.). 14 Aug 1972. 10p. Dep. NTIS.

49927 (DOCKET-50363-35) FORKED RIVER NUCLEAR GENERATING STATION, UNIT 1. Preliminary Safety Analysis Report, Amendment 21. (Jersey Central Power and Light Co., Morristown, N. J.). 21 Aug 1972. 9p. Dep. NTIS.

Revised information is presented concerning earthquake stress characteristics of Class 1 structures and equipment. (D.C.C.)

49928 (DOCKET-50367-29) BAILLY GENERATING STATION, NUCLEAR I. Preliminary Safety Analysis Report, Amendment 16. (Northern Indiana Public Service Co., Hammond). 21 Aug 1972. 77p. Dep. NTIS.

Revised and additional data are presented concerning the emergency plan for the Bailly Power Reactor Unit 1. (D.C.C.)

49929 (DOCKET-50373-26) LA SALLE COUNTY STATION, UNITS 1 AND 2. Safety Evaluation. (Directorate of Licensing (AEC), Washington, D. C.). 21 Aug 1972. 157p. (DOCKET-50374-25). Dep. NTIS.

49930 (DOCKET-50382-33) WATERFORD STEAM ELECTRIC STATION, UNIT 3. Preliminary Safety Analysis Report, Amendment 21. (Louisiana Power and Light Co., New Orleans). 18 Aug 1972. 13p. Dep. NTIS.

The preliminary safety analysis report for the Waterford Power Reactor Unit 3 is amended by the submission of revised and requested safety information. Requested information on radioactive effluents is presented. (D.C.C.)

49931 (DOCKET-50382-34) WATERFORD STEAM ELECTRIC STATION, UNITS 3 AND 4. Antitrust Hearing will not be Necessary if Certain Commitments are Imposed as License Conditions. (Department of Justice, Washington, D. C. Antitrust Div.). 18 Aug 1972. 10p. (DOCKET-50383-13). Dep. NTIS.

49932 (DOCKET-50390-20) WATTS BAR NUCLEAR PLANT, UNITS 1 AND 2. Preliminary Safety Analysis Report, Amendment 13. (Tennessee Valley Authority, Chattanooga). 14 Aug 1972. 135p. (DOCKET-50391-20). Dep. NTIS.

The preliminary safety analysis report for the Watts Bar Power Reactor Units 1 and 2 is amended by the submission of revised and additional safety information. Meteorological data for the reactor site are included. (D.C.C.)

49933 (DOCKET-50395-26) VIRGIL C. SUMMER NUCLEAR STATION, UNIT 1. Preliminary Safety Analysis Report, Amendment 14. (South Carolina Electric and Gas Co., Columbia). 15 Aug 1972. 60p. Dep. NTIS.

The preliminary safety analysis report for the Virgil C. Summer Power Reactor Unit 1 is amended by the submission of revised and additional safety information. (D.C.C.)

49934 (DOCKET-50397-22) HANFORD NO. 2 NUCLEAR POWER PLANT. Environmental Report, Basic Data for Source Term Calculation. (Washington Public Power Supply System, Richland). 11 May 1972. 12p. Dep. NTIS.

Requested information is presented concerning radioactive discharges from the reactor. (D.C.C.)

49935 (DOCKET-50397-23) HANFORD NO. 2 NUCLEAR POWER PLANT. Draft Environmental Statement. (Washington Public Power Supply System, Richland). Aug 1972. 195p. Dep. NTIS.

Information concerning chemical, radioactive, and thermal discharges from the reactor is presented. The effects of reactor operations on the environment are analyzed. Geological, ecological, hydrological, and meteorological data for the reactor site are included. Cost-benefit analysis of reactor operation is presented. (D.C.C.)

49936 (DOCKET-50400-22) SHEARON HARRIS NUCLEAR POWER PLANT, UNITS 1, 2, 3, AND 4. Preliminary Safety Analysis Report, Amendment 13. (Carolina Power and Light Co., Raleigh, N. C.). 18 Aug 1972. 320p. (DOCKET-50401-22; DOCKET-50402-22; DOCKET-50403-22). Dep. NTIS.

The preliminary safety analysis report for the Shearon Harris Power Reactor Units 1, 2, 3, and 4 is amended by the submission of revised and requested safety information. (D.C.C.)

49937 (DOCKET-50404-21) NORTH ANNA POWER STATION, UNITS 3 AND 4. Preliminary Safety Analysis Report, Amendment 7. (Virginia Electric and Power Co., Richmond). 15 Aug 1972. 552p. (DOCKET-50405-21). Dep. NTIS.

The preliminary safety analysis report for the North Anna Power Reactor Units 3 and 4 is amended by the submission of revised and requested safety information. (D.C.C.)

49938 (DOCKET-50410-9) NINE MILE POINT NUCLEAR STATION, UNIT 2. Preliminary Safety Analysis Report, Amendment 1. (Niagara Mohawk Power Corp., Syracuse, N. Y.). 18 Aug 1972. 44p. Dep. NTIS.

The preliminary safety analysis report for the Nine Mile Point Power Reactor Unit 2 is amended by the submission of revised and additional safety information. (D.C.C.)

49939 (FIND-50282(7-72)) FIND: PRAIRIE ISLAND NUCLEAR GENERATING PLANT, UNITS 1 AND 2. Smith, James G. (ed.) (Technical Information Center (AEC), Oak Ridge, Tenn.). 31 Jul 1972. 34p. (FIND-50306(7-72)). Dep. NTIS.

An index to microfiche issuances of safety analysis reports is provided. Subject citations are to specific frames on the microfiche. (J.M.J.)

49940 (ORNL-NSIC-105) INDEXED BIBLIOGRAPHY ON NUCLEAR FACILITY SITING. Piper, Henry B. (Oak Ridge National Lab., Tenn.). Jun 1972. Contract W-7405-eng-26. 278p. Dep. NTIS.

Included are 900 abstracts of documents that pertain to various phases of siting; for example, design, operation, environment, population, seismicity, weather, safety features, and other aspects of the plant and its site. About one-third of the abstracts are concerned with the various reports and questions and responses that arise during the licensing of a nuclear plant. Keyword and Author Indexes and a KeyWord In Context (KWIC) listing of titles are provided. (auth)

49941 (ORO-4067-2) THERMAL EFFECTS OF THE SURRY NUCLEAR POWER PLANT ON THE JAMES RIVER, VIRGINIA. PART II. RESULTS OF MONITORING PHYSICAL PARAMETERS OF THE ENVIRONMENT PRIOR TO PLANT OPERATION. Chia, S. N.; Fang, C. S.; Bolus, R. L.; Hargis, W. J. Jr. (Virginia Inst. of Marine Science, Gloucester Point). Feb 1972. Contract AT-(40-1)-4067. 349p. Dep. NTIS.

The thermal structure of the James River Estuary was studied in the area of the future discharges from the nuclear power plant at Hog Point in Surry County, Virginia. The plant is scheduled to become operational with one unit generating 800 MW in the summer of 1972 and with a second identical unit in the spring of 1973. This study will help to evaluate the potential environmental effects from the waste heat discharged from the power plant when it becomes operational. The thermal field adjacent to the intended discharge area and the thermal distributions in the estuary have been plotted in this report for the spring, summer, and fall of 1971. These plots will be used as the natural background data for future comparisons with plots made after the plant becomes operational. From such comparisons we will be able to determine whether or not the plant will have significant effects on the thermal regime. Likelihood of biological damage in that part of the James River Estuary will then be possible to assess. (auth)

49942 (RDT-F-1-1(7-72)) PREPARATION OF RDT STANDARDS. (Division of Reactor Development and Technology (AEC), Washington, D. C.). Jul 1972. 45p. RSO.

Requirements and guidance for the preparation, review, approval, amendment, modification, revision and application of RDT standards are presented. The purpose of this standard is to ensure that the organization, format and processing of standards, amendments and revisions are uniform and consistent. Requests for deviation from the requirements of this standard shall be justified by the requestor and approved by the Division of Reactor Development and Technology (RDT), U. S. Atomic Energy Commission. (auth)

49943 (RDT-STATUS-6-72) BIMONTHLY STATUS REPORT OF RDT STANDARDS FOR THE PERIOD ENDING MAY 31, 1972.

(Division of Reactor Development and Technology (AEC), Washington, D. C.). 13 Jun 1972. 46p. RSO.

Information is presented concerning additions and revisions to USAEC RDT standards during April and May 1972. New standards approved during the reporting period are listed. (D.C.C.)

49944 INSTITUTE OF ENVIRONMENTAL SCIENCES 1972 PROCEEDINGS. ENVIRONMENTAL PROGRESS IN SCIENCE AND EDUCATION. 18th Annual Technical Meeting, New York, New York, May 1–4, 1972. Mt. Prospect, Ill.; Institute of Environmental Sciences (1972). 610p. (CONF-720511).

Separate abstracts are included for 4 of the 90 papers presented concerning developments in environmental sciences. (D.C.C.)

For abstracts of individual papers see: 49805, 49806, 49849, and 49945.

49945 CERTIFICATION OF LARGE EQUIPMENT DURABILITY TO SEISMIC VIBRATION ENVIRONMENTS FOR NUCLEAR POWER PLANT USE. Rheuble, David M. pp 296-302 of Institute of Environmental Sciences 1972 Proceedings. Environmental Progress in Science and Education. Mt. Prospect, Ill.; Inst. of Environmental Sciences (1972).

From eighteenth annual meeting on environmental progress in science and education, New York, NY. (1 May 1972). See CONF-720511.

A method of obtaining earthquake vibration qualification of large power plant equipment is described. It is simple and direct. It avoids engineering assumptions and is mathematically valid. It requires a minimum of test equipment and computation skills. (auth)

Steam and Power Conversion System

49946 (RDT-E-4-16-T(5-72)) SODIUM-HEATED STEAM GENERATOR. (Division of Reactor Development and Technology (AEC), Washington, D. C.). May 1972. 45p. RSO.

The requirements for the design, material selection, fabrication, testing, inspection, and installation of sodium-heated steam generators for LMFBR plant applications are defined. Steam generators designed, built, tested, and inspected in accordance with this standard will meet the requirements of Section III of the ASME Boiler and Pressure Vessel Code. Accessories, including boiler drums, piping, and separators, are not within the province of this standard. (auth)

Propulsion and Auxiliary Power Reactors

Refer also to abstracts 48178, 48390, 48452, and 49999.

49947 (AED-C-22-12) BIBLIOGRAPHIES IN NUCLEAR SCIENCE AND TECHNOLOGY. Section 22: Nuclear Ship Propulsion. (Zentralstelle fuer Atomkernenergie-Dokumentation, Leopoldshafen (West Germany)). 1972. 36p. (In several languages). Dep. NTIS (U. S. Sales Only).

References are cited on the design, construction, operation, and safety of nuclear powered merchant vessels. Author and subject indexes are included. (H.D.R.)

49948 (AED-C-22-13) BIBLIOGRAPHIES IN NUCLEAR SCIENCE AND TECHNOLOGY. SECTION 22: NUCLEAR SHIP PROPULSION. (Zentralstelle fuer Atomkernenergie-Dokumentation, Frankfurt am Main (West Germany)). Apr 1972. 27p. Dep. NTIS (U. S. Sales Only).

105 citations to report and published literature are presented without annotation. Titles are in language of origin. Author and subject (in German) indexes are included. (J.M.J.)

49949 (LA-4977) NUCLEAR SAFETY OF AN AIRBORNE FAST REACTOR. Final Report of the Reactor Criticality Analysis Program. Vigil, J. C.; Carmichael, B. M.; Best, G. H. (Los Alamos Scientific Lab., N. Mex.). Jun 1972. Contract W-7405-eng-36. 5p. Dep. NTIS.

Neutronic calculations were performed for an airborne fast reactor concept in order to evaluate safety aspects of compactions and coolant voiding. The reactor will remain subcritical under severe compactions provided that (1) all the control elements are inserted prior to compaction, (2) the control material uses ^{10}B rather than natural boron, and (3) the excess reactivity at the beginning-of-life is less than 6.8%. Voiding of the metal coolant produces only a small reactivity effect. (8 references) (auth)

49950 (NAA-SR-Memo-8054) SNAP REACTOR SYSTEMS FOR THE LUNAR LOGISTICS POWER PLANT PAYLOAD. Ackermann, W. O. Jr.; Estrada, E.; Flower, L. M.; Keshishian, V.; Konklin, J. E.; Wimmer, R. E. (Atomics International, Canoga Park, Calif.). 15 Jan 1963. Contract AT-11-1-GEN-8. 136p. Dep. NTIS.

Declassified 4 Nov 1971.

Studies have shown that SNAP power plants can be landed and operated on the moon with only minor modifications. Since weight considerations preclude the shipment of a fully shielded reactor, it is believed that modification would be more satisfactory to the projected missions. Two concepts were considered; (1) an unshielded reactor utilizing terrain for radiation protection, and (2) burying the reactor to utilize moon soil for shielding. Burial would require both configuration and some component changes. Suggested modifications to both SNAP-2 and SNAP-10 are described. (J.M.J.)

49951 (NAA-SR-Memo-9602) HOT CHANNEL EFFECT ON FUEL TEMPERATURE. Treuenfels, E. W. (Atomics International, Canoga Park, Calif.). 2 Mar 1964. Contract AT-11-1-GEN-8. 15p. Dep. NTIS.

Declassified 2 Nov 1971.

Three SNAP 2 fuel elements surrounding a coolant channel may all have fuel inside the cladding eccentrically shifted towards this coolant channel. The additive effect will raise the coolant exit temperature by 17°F and the maximum fuel temperature by 10°F if the reactor power is 55 kw thermal. The probability of this happening in a reactor is appreciably less than 10%. (auth)

49952 (NP-19339) ANNUAL REPORT, 1970. (Gesellschaft fuer Kernenergieverwertung in Schiffbau und Schiffahrt m.b.H., Hamburg (West Germany)). 183p. (In German). Dep. NTIS (U. S. Sales Only).

With the annual report 1970, the society for nuclear energy application in ship building and navigation gives a comprehensive presentation of its scientific and technical studies. In addition to the experimental projects performed in 1970, a brief survey is presented about development of the society, available installations, and organizational setup. Among the research and development projects, the report contains operation experience and research studies with the Otto Hahn; the second core for the FDR of the Otto Hahn; development of the advanced pressure water container; high temperature reactor; nuclear power plant Schleswig–Holstein; desalination of ocean water; oceanography; developmental work for nuclear-propelled ships; studies for removal of solid poisons; studies on zirconium alloys; irradiation behavior of pressure vessel steels; and development of computer programs for the nuclear and thermodynamic layout of reactors. 30 references. (H.B.G.)

Process Heat and Desalination Reactors

Refer also to abstract 47946.

49953 (CONF-700926-(Vol.3)) PROCEEDINGS OF THE THIRD INTERNATIONAL SYMPOSIUM ON FRESH WATER FROM THE SEA, DUBROVNIK, 13–17 SEPTEMBER 1970. VOLUME 3. FREEZING PROCESSES ECONOMIC CONSIDERATIONS. Delyannis, A.; Delyannis, E. (eds.) (European Federation of Chemical Engineering. Working Party on Fresh Water From the Sea). 500p. (In several languages).

Separate abstracts are included for 3 of the 37 papers presented on desalination. (D.C.C.)

For abstracts of individual papers see: 49954–49956.

49954 (CONF-700926-(Vol.3), pp 193-202) ECONOMICS OF NUCLEAR DESALINATION IN JAPAN, WITH SPECIAL REFERENCE TO THE INTERCONNECTION WITH CONVENTIONAL WATER SUPPLY SYSTEM. Suetsuna, Ichiro (Japan Atomic Industrial Forum, Tokyo); Ito, Akihide.

From third international symposium on fresh water from the sea; Dubrovnik, Yugoslavia (13 Sep 1970).

49955 (CONF-700926-(Vol.3), pp 205-15) DUAL-PURPOSE POWER DESALINATION NUCLEAR PLANT WITH TYPE WWER-400 REACTOR FOR THE SOUTHERN UKRAINE. Alksnis, G. G.; Kruglikov, G. V. (State Committee for Utilization of Atomic Energy, Moscow).

From third international symposium on fresh water from the sea; Dubrovnik, Yugoslavia (13 Sep 1970).

The principal engineering concepts which the dual-purpose desalination plant is based upon are presented. As a heat source for the desalination plant the type WWER-400 reactor is used; the prototype of this reactor functions successfully at Novo-Voronezh nuclear power plant. For water desalination the multi-stage flash evaporators made of metal are used. 8 references. (auth)

49956 (CONF-700926-(Vol.3), pp 217-23) NEW DESIGN OF THE ROVI NUCLEAR REACTOR PROTOTYPE FOR WATER-ONLY PRODUCTION. Di Menza, R. (CNEN, Rome). (In English and French).

From third international symposium on fresh water from the sea; Dubrovnik, Yugoslavia (13 Sep 1970).

ROVI has recently been revised from the original design of a demonstration plant. The resulting major changes are related to the reactor power that has been increased to 220 MW(t), the organic fluid that has been changed to an hydrogenated mixture liquid at room temperature, and to the possibility of operating at such conditions that would enable the production of small quantities of electrical energy. The desalting plant can produce, according to the specific power consumption, up to 110,000 cubic meters of fresh water per day. An evaluation has been completed of the capital and operating costs of a standard solution. (auth)

49957 (CONF-710444-10) HIGH-TEMPERATURE REACTORS FOR GENERATION OF NUCLEAR PROCESS HEAT. Schulten, R. (Kernforschungsanlage, Juelich (West Germany). Institut fuer Reaktorentwicklung); Cautius, W. (Arbeitsgemeinschaft Versuchs-Reaktor G.m.b.H., Duesseldorf (West Germany)). 1971. 16p. Dep. NTIS (U. S. Sales Only).

From International conference on chemical sciences; Paris, France (20 Apr 1971).

The high temperature reactors developed have a satisfactory performance concerning the contamination of circuits and safety features. The once-through pebble system allows an average gas outlet-temperature of 950°C to be reached and a temperature of 1200°C to be envisaged in the future. This reactor is characterized by its highly simplified and flexible fuel cycle optimization. Atomic power plants functioning with these reactors are able to produce steam and electricity. The following topics are envisaged to be of interest in the near future: production of superheated steam for the chemical industry and refinery plants; production of hydrogen from natural gas and petroleum; processing of heavy crude oil; production of olefins from petroleum; gasification of coal. The development of these processes is currently being studied in the Federal Republic of Germany. Helium-heated gasification compounds for the processing of carbon and brown coal are envisaged for the future. (France)

49958 (JUL-823-RG) PRESSURE COMPENSATION BETWEEN CONTAINERS. Barnert, Heiko (Kernforschungsanlage, Juelich (West Germany). Institut fuer Reaktorentwicklung). Jan 1972. 61p. (In German). Dep. NTIS (U. S. Sales Only).

Calculation formula for conditions at pressure compensation between two containers filled with gas are developed for adiabatic and isothermal expansion by means of a simple container model. These formula are used for the "break of a pressure-retaining wall in the primary circuit" of a process heat reactor (gas-cooled high-temperature pebble-bed reactor of a non-integrated system), e.g., for the accident "Break of a coaxial conduit". The influence of different parameters is studied. 9 references. (auth)

49959 (ORNL-NDIC-12) REVIEW OF CALIFORNIA'S REGIONAL WATER SUPPLY SYSTEMS AND POSSIBLE APPLICATIONS OF DESALTING. Thompson, W. E. (Oak Ridge National Lab., Tenn.). Jun 1972. Contract W-7405-eng-26. 102p. Dep. NTIS.

California's development of water storage and conveyance facilities is described. The California State Water Project, when its main aqueduct facilities are completed in 1973, will be capable of delivering 3800 Mgd to service areas along its route from the Sacramento River delta to southern California. This system will meet southern California's estimated water requirements at least through 1990 at rates of 14 to 25¢ per 1000 gal for untreated water. Water from the State Water Project will be delivered in central California service areas at rates of 4 to 10¢ per 1000 gal. When additional water is needed after 1990 on the southern California coast, seawater desalting plants may be economically competitive in supplying some of the needs. Desalting of geothermal brines in the Imperial Valley or of seawater from the Gulf of California may be attractive for overcoming problems of salinity of the Colorado River water as well as providing additional water to meet future needs in this region. (30 references) (auth)

Research and Test Reactors

Refer also to abstracts 48483, 49316, 49812, and 49815.

49960 (AAEC/TM-609) ANALOGUE STUDIES OF POWER TRANSIENTS PRODUCED BY REACTIVITY CHANGES IN THE MATERIALS TESTING REACTOR HIFAR LOADED WITH MK III 150 GRAM FUEL ELEMENTS. Wilson, D. J. (Australian Atomic Energy Commission Research Establishment, Lucas Heights). Mar 1972. 42p. Dep. NTIS (U. S. Sales Only).

The HIFAR reactor, loaded with a core of 150 g Mark III fuel elements, was simulated using the PACE analogue computer to assess expected power transients following positive reactivity additions. If five coarse control arms operate, and the operational power is 85% of the trip level, the power transient from an initial 15 MW will not exceed 30 MW if the rate of addition of reactivity does not exceed 0.535% $\delta k/k$ per second, or a step addition does not exceed 0.342 $\delta k/k$. The peak power attained is influenced by the delay in releasing, and by the initial setting of, the coarse control arms. 5 references. (auth)

49961 (AI-68-Memo-53) STUDIES OF THE DISTRIBUTION OF MASS RELEASED INTO THE FFTF HOT CELL AFTER THE DBA. Interim Report. Koontz, R. L.; Greenfield, M. A.; Hausknecht, D. F.; Silberberg, M. (Atomics International, Canoga Park, Calif.). 22 May 1968. 78p. Dep. NTIS.

The study described represents the correlation and application of experimental and analytical modeling data to the evaluation of the fate of fuel, sodium, and radionuclides released as a result of the postulated design basis accident (DBA) for the FFTF. By using the existing knowledge of the behavior of aerosols, it is shown that the potential hazards of the DBA are greatly reduced. This reduction occurs because of two mechanisms: (1) the use of double containment and the resultant low leak rate from the outer containment at early times after the DBA and (2) the predominant reduction of the source term produced in the inner containment system (FFTF hot cell) by the agglomeration and fallout of the materials released during the accident. In order to justify the hypothesis used in the analysis, a brief description of the state-of-the-art knowledge about aerosols, agglomeration, and fission product deposition on aerosols is presented. A correlation between laboratory experiments and modeling techniques is shown to be possible through the use of rigorous physical principles. Next, the derivation of an empirical relationship for characterizing aerosol behavior is shown to be consistent with results from laboratory tests. The development of an engineering mass model (EMM) programmed for solution on a digital computer is presented and its general agreement with laboratory data is substantiated. This analytical tool was then utilized for a parametric study of the spatial and temporal distribution of the materials released to the FFTF hot cell following the DBA, for various specified conditions. Finally, the results of these computations are summarized and discussed in terms of their significance and application to safeguards evaluation. 41 references. (auth)

49962 (ANCR-1075) PBF ADMINISTRATIVE CONTROL OF CONSTRUCTION COMPONENT TESTS. Heffner, R. E. (Aerojet Nuclear Co., Idaho Falls, Idaho). Jul 1972. Contract AT(10-1)-1375. 24p. Dep. NTIS.

The mechanisms for the generation and administrative control of construction component tests for PBF are presented. Interface relationship and required approvals are delineated in the text. (auth)

49963 (ANL-7940) OXYGEN-HYDROGEN METER MODULE FOR LMFBR's: DESIGN AND OPERATION. Kolba, V. M.; Slawecki, M. A.; Filewicz, E. C.; Vissers, D. R.; Raue, D. J.; Holmes, J. T.; Nelson, P. A. (Argonne National Lab., Ill.). May 1972. Contract W-31-109-eng-38. 20p. Dep. NTIS.

An oxygen-hydrogen meter (O-H) module, which houses two electrochemical oxygen meters and a diffusion-type hydrogen meter, was designed for use on FFTF. The meters will serve as on-line monitors of oxygen and hydrogen activity in liquid sodium systems. Prototype units were fabricated and tested, one on a small laboratory loop and the other on the Radioactive Sodium Chemistry Loop at EBR-II. Module component operation and overall system operation were verified. Oxygen meter calibration curves were obtained, and the response of the hydrogen meter to changes in hydrogen content of the sodium was defined. (auth)

49964 (ANL-7941) CARBON METER-EQUILIBRATION MODULE FOR LMFBR's: DESIGN AND OPERATION. Kolba, V. M.; Slawecki, M. A.; Filewicz, E. C.; McKee, J. M.; Holmes, J. T.; Nelson, P. A. (Argonne National Lab., Ill.). May 1972. Contract W-31-109-eng-38. 19p. Dep. NTIS.

A carbon meter-equilibration (C-E) module, which can be used for equilibration of metal specimens or, with an appropriate probe, as an on-line monitor of carbon activity in liquid sodium, was designed. This unit was designed to fit a module of space in the FFTF In-Line Instrument Packages. Prototype units were fabricated and tested, one on a small laboratory loop and the other on the Radioactive Sodium Chemistry Loop at EBR-II. Module component operation and overall system operation were verified. (auth)

49965 (CONF-720607-2) QUALITY ASSURANCE TECHNIQUES FOR ON-LINE PROCESS COMPUTER SOFTWARE. Bullock, J. B. (Oak Ridge National Lab., Tenn.). 27 Jan 1972. 4p. Dep. NTIS.

From eighteenth annual American Nuclear Society conference; Las Vegas, NV. (18 Jun 1972).

The practices implemented at the ORNL High Flux Isotope Reactor to assure the integrity of process computer software are described. (H.D.R.)

49966 (CONF-720607-3) DIRECT DIGITAL COMPUTER SHIM ROD CONTROL FOR THE HFIR. Bullock, J. B. (Oak Ridge National Lab., Tenn.). 27 Jan 1972. 4p. Dep. NTIS.

From 18. annual American Nuclear Society conference; Las Vegas, NV. (18 Jun 1972).

49967 (EUR-4782) OPERATIONS GROUP OF THE BR2 REACTOR AND ITS ASSOCIATED FACILITIES. Annual Progress Report, 1969. (European Atomic Energy Community. Centre d'Etude de l'Energie Nucleaire, Mol (Belgium)). 1972. 47p. Dep. NTIS (U. S. Sales Only). EUR B. Fr. 70.-.

Operation of the BR2 and its associated installations was carried out under the Contract of Association signed between Euratom and the CEN. By the terms of this Contract, concluded in 1960 for a period of twenty years, the parties concerned use the installations, which are operated jointly, for their own purposes; they may also make them available to any other parties they please for the latter's requirements. Implementation of the Contract is directed by a Management Committee, which met five times in 1969 to draw up the programs and ensure the technical coordination of the various uses to which the installations are put. Since 1963 the operation of the reactor has proved the real advantages which it derives from its unique characteristics (high flux, operational flexibility) and in particular its ability to satisfy the new requirements of experimental workers. In 1969 the help given by BR2 to the large-scale nuclear projects of the European Community was again increased, especially in connection with the fast reactor program. The year 1969 was marked by the introduction of the agreement with the Gesellschaft für Kernenergie, Karlsruhe, whereby they pay approximately one half of the running costs, and receive approximately one half of the BR2 radiation facilities for the German program.

49968 (EUR-4790) OPERATIONS GROUP OF THE BR2 REACTOR AND ITS ASSOCIATED FACILITIES. Annual Progress Report, 1970. (European Atomic Energy Community. Centre d'Etude de l'Energie Nucleaire, Brussels (Belgium)). 1972. 44p. Dep. NTIS (U. S. Sales Only). EUR B. Fr. 70.-.

Operation of the BR2 and its associated installations was carried out under the Contract of Association signed between Euratom and the CEN. By the terms of this Contract, concluded in 1960 for a period of twenty years, the parties concerned use the installations, which are operated jointly, for their own purposes; they may also make them available to third parties for the latter's requirements. Implementation of the Contract is directed by a Management Committee, which met 4 times in 1970 to draw up the programs and ensure the technical coordination of the various uses to which the installations, are put. Since 1963 the operation of the reactor has proved the real advantages which it derives from its unique characteristics (high flux, operational flexibility) and in particular its ability to satisfy the new requirements of experimental workers. In 1970 the help given by BR2 to the large-scale nuclear projects of the European Community was still further increased, in particular in the field of fast reactor development, which accounted for ⅔ of the total reactor utilization. (auth)

49969 (EUR-4803) POTENTIAL BR2 IRRADIATION TEST FACILITIES FOR GBR FUEL. von der Hardt, P. (Centre d'Etude de l'Energie Nucleaire, Mol (Belgium)). 1972. 38p. Dep. NTIS (U. S. Sales Only). EUR B.Fr. 60.-.

Potential contributions from irradiation testing in BR2 to fuel and materials development for the Gas-Cooled Fast Breeder Reactor can originate from the existing liquid metal cooled devices and high temperature rigs as well as from new designs, mainly in-pile gas loops. Short descriptions of available and possible BR2 facilities are given, together with their performance figures, with particular reference to GBR parameters. 17 references. (auth)

49970 (GEAP-10010-31) SOUTHWEST EXPERIMENTAL FAST OXIDE REACTOR DEVELOPMENT PROGRAM. Thirty-First and Final Quarterly Report, November 1971-January 1972. Pflasterer, G. R.; Becker, R. A. (comps.) (General Electric Co., Sunnyvale, Calif. Breeder Reactor Dept.). Feb 1972. Contract AT(04-3)-540. 156p. Dep. NTIS.

SOUTHWEST EXPERIMENTAL FAST OXIDE REACTOR—fuel elements for, fabrication and design parameters of plutonium oxide (PuO_2)—uranium oxide (UO_2)
—physics measurements during calibration of FRED rod, super-prompt transient
—reflector in, measurement of reactivity worth of
—safety evaluation of
—protective devices for, modification of
—shutdown of, procedures for
—operation of, summary of
—maintenance of, summary of (J.M.J.)

49971 (GEAP-10548) SEFOR COLD-TRAP EXPERIENCE. Gadeken, A. D.; Plummer, M. C. (General Electric Co., Sunnyvale, Calif. Breeder Reactor Dept.). Apr 1972. Contract AT(04-3)-540. 38p. Dep. NTIS.

The SEFOR cold traps installed in the primary sodium service system developed flow control problems very early in life. These early flow problems, aggravated by large temperature differences between plugging temperatures and cold-trap control temperature, soon degenerated into complete flow blockage of both cold traps. After approximately 1500 hours of operation for each cold trap during sub-power testing, the cold traps were removed from the system and replaced by cold traps of similar design. The two plugged cold traps were drained of sodium in a procedure which was designed to leave the oxide precipitation intact in the cold trap. The cold traps were then disassembled, inspected, and photographed in an inert atmosphere. This inspection procedure revealed that: the cold traps had only trapped about one-quarter of their design capacity of oxide, the mesh inside the cold traps had been compressed to about one-third of the original size, and except for the first mesh wafer seen by the oxide-laden sodium, there was very little oxide precipitate in the five succeeding mesh wafers. The SEFOR cold-trap experience has resulted in an operating procedure for the new cold traps which eliminates the large temperature differences between sodium plugging temperature, and a much better understanding of the initial cold-trap plugging problems. (auth)

49972 (GEAP-13771-2) CRITICAL EXPERIMENTS AND COOPERATIVE EVALUATIONS PROGRAM. Second Quarterly Report, January-March 1972. (General Electric Co., Sunnyvale, Calif. Breeder Reactor Dept.). Apr 1972. Contract AT(04-3)-189. 60p. Dep. NTIS.

Current activities and technical progress for the period January through March, 1972, are reported for two tasks. Task A covers the planning and analysis of critical experiments in ZPPR-3. Task B progress is reported for nuclear data evaluation and testing and methods development in support of Task A. (18 references) (auth)

49973 (HEDL-TME-71-25) FFTF OUTLET REGION FEATURE MODEL: 300 SERIES AIR ENTRAINMENT TESTS REPORT. Spalek, J.; Ballard, D. L.; Sweetin, L. R. (Hanford Engineering Development Lab., Richland, Wash.). Feb 1971. Contract AT-(45-1)-2170. 40p. Dep. NTIS.

A series of water model tests were performed as a part of the FFTF development program. The results of the 300 Series tests, performed in a dynamic water model of the FFTF, for the evaluation of potential air entrainment problems are reported. Tests were conducted to show the effectiveness of a vortex suppression plate positioned just below the liquid pool surface. Both visual and ultrasonic data were obtained and recorded for conditions with and without the suppression plate being in position. Air entrainment in the liquid pool is reduced to essentially zero in the reference design configuration. 17 references. (auth)

49974 (HEDL-TME-71-27) FTR FISSION PRODUCT DECAY HEAT. Marr, D. R.; Bunch, W. L. (Hanford Engineering Development Lab., Richland, Wash.). Feb 1971. Contract AT(45-1)-2170. 67p. Dep. NTIS.

The decay heat associated with driver fuel irradiated to goal exposure in the fast test reactor (FTR) was calculated by using the RIBD computer code with a special nuclear data library containing 770 isotopes or isomeric states. A statistical array of unknown, short half-life isotopes was included in the library to achieve agreement with available experimental data. Decay energies and half-lives of these isotopes were established empirically. An uncertainty estimate was made to indicate the limitations in the results introduced by the available input information. Libraries also were generated for a number of fast reactor fuels other than ^{239}Pu and ^{238}U, which make it possible to calculate decay heat curves for essentially any fuel or combination of fuels in any reactor environment and for any irradiation history. 37 references. (auth)

49975 (HEDL-TME-71-48) FFTF OUTLET REGION FEATURE MODEL LOCALIZED POOL VELOCITIES. Polentz, L. M.; Ballard, D. L.; Nunamaker, F. H. (Hanford Engineering Development Lab., Richland, Wash.). Dec 1971. Contract AT(45-1)-2170. 60p. Dep. NTIS.

Measurements were made of the local velocity of fluid in a scale model of the FFTF reactor pool at a number of selected locations in a one-third sector. The purpose of the measurements was twofold: to determine the flow pattern above the reactor core and in the outlet pool, and to determine the magnitude and direction of the fluid velocity at representative points to permit an estimate of the possibility of flow-induced vibration of the reactor pool components. The velocity was measured for a gross model flow rate (3010 gpm) which simulated actual reactor velocity. Data were taken at 20 planar positions and 12 elevations in the outer pool from an elevation at the top of the outlet nozzles up to near the pool surface. The measured velocities (speed, pitch angle, and yaw angle) are tabulated. (auth)

49976 (HEDL-TME-71-120(Rev.1)) CONTEXTUAL INDEX FOR FFTF PSAR. Supplementary Documentation. (Hanford Engineering Development Lab., Richland, Wash.). Aug 1971. Contract AT(45-1)-2170. 21p. Dep. NTIS.

The Preliminary Safety Analysis Report (PSAR) for the Fast Flux Test Facility presents a description of the reactor plant and an evaluation of the plant relative to safety features and considerations which support the conclusion that the facility may be safely built and operated. Since submittal of the PSAR in September 1970, substantially more work has been completed and documented in the form of supplemental information. In order to provide a convenient orientation of the supplemental documentation to the initial submittal, this contextual index has been prepared to identify each supplemental document, to provide a brief description of each document's content, and to identify the sections of the initial submittal to which the supplemental document primarily applies. (auth)

49977 (HEDL-TME-72-39) CCTL MARK II FUEL ASSEMBLY INTERIM EXAMINATION AND MODIFICATION. Myers, R. L. (Hanford Engineering Development Lab., Richland, Wash.). May 1972. Contract AT(45-1)-2170. 40p. Dep. NTIS.

In March, 1971, the Mark II prototypic FTR driver fuel assembly completed 6,000 hours of a scheduled 9,000-hour sodium flow test in the Core Components Test Loop (CCTL). An interim examination was performed at the Hanford Engineering Development Laboratory (HEDL), after which the assembly was modified and returned to the CCTL for completion of the test. There were no significant evidences of excessive vibration, wear, structural damage or corrosion. An important observation was the presence of foreign particles on the assembly components. (auth)

49978 (HEDL-TME-72-78) SEFOR-CORE I DOPPLER CONSTANT ANALYSIS. Harris, R. A.; Nelson, J. V. (Hanford Engineering Development Lab., Richland, Wash.). Apr 1972. Contract AT(45-1)-2170. 55p. Dep. NTIS.

The SEFOR-Core I Doppler constant [T(dk/dT)] has been calculated using the models and methods adopted for the design of the FTR. This calculated value (–.0081) compares quite well with the value deduced by General Electric from several experiments (–.0081 ± .0014). However, a preliminary HEDL analysis of the super-prompt series of transient experiments indicates that the experimentally inferred Doppler constant could be as much as 20% more negative than –.0081. In order to make the SEFOR results more useful in assessing the uncertainty in the calculated Doppler constant for FTR, several aspects of the differences between SEFOR and FTR have been investigated. 25 references. (auth)

49979 (INR-1334) THERMAL NEUTRON MICRODISTRIBUTION STUDIES IN "ANNA" REACTOR LATTICES. SUPPLEMENT. Jozefowicz, Edward T. (Institute of Nuclear Research, Warsaw (Poland)). 1972. 18p. Dep. NTIS (U. S. Sales Only).

Some auxiliary experiments on perturbations in thermal neutron microdistribution measurements in elementary cells of the zero power reactor ANNA were performed to verify the previously published results and methods. The detailed comparison of the experimental results with the new calculations using S-III-THERMOS Code is given. The possible sources of some discrepancies are checked and discussed. 10 references. (auth)

49980 (JUL-824-RB) STUDIES ON HEAT AND FLOW TECHNIQUES FOR THE APPLICATION OF DIRECTLY COOLED CHARGES OF COATED PARTICLES IN FUEL ELEMENTS. Barthels, H. (Kernforschungsanlage, Juelich (West Germany). Institut fuer Reaktorbauelemente). Jan 1972. 36p. (In German). Dep. NTIS (U. S. Sales Only).

Theoretical studies of both flow and pressure losses in a directly cooled coated particle element with distributing and collecting channels are reported. Pressure conditions for a representative element were measured and compared with the calculations. Allowable deviations in FRJ-2 fuel element geometry were calculated. The coolant distribution in the fuel layer and the resulting temperature distribution were calculated by considering a large variation of fuel element length, coated particle diameter, hollow tube resistance, and flow direction, as presented graphically. 14 references. (auth)

49981 (KFK-746) OPERATIONS REPORT FOR THE RESEARCH REACTOR FR2 FOR THE YEAR 1969. Steiger, W.; Wildberg, D. (Kernforschungszentrum, Karlsruhe (West Germany)). Feb 1972. 153p. (In German). Dep. NTIS (U. S. Sales Only).

The 10 operational phases of 5 weeks each which had been scheduled for operation at the design power level of 44 MW in 1969 were largely met. An extension of the "H"-phase and a corresponding reduction of the "L"-phase were due to the installation of the in-pile rig for the can burst steam loop. The use of FR2 for experiments continued to increase in 1969. The three loop experiments already in operation were added to the can burst steam loop, which was commissioned by the middle of the year, and the start of out-of-pile trial operation of the pressurized water loop for fuel plate irradiation. Additional capsule irradiations were accommodated by installing adapters in those intermediate grid positions which were still available. Relative to previous years, isotope production has decreased slightly. A total of 1327 capsules were irradiated. 9 references. (auth)

49982 (KFKI-72-34) STATUS REPORT ON IN-PILE CALORIMETRY IN HUNGARY. Szabo, F.; Bod, L.; Gizella, A. (Magyar Tudomanyos Akademia Kozponti Fizikai Kutato Intezete, Budapest). 1972. 10p. Dep. NTIS (U. S. Sales Only).

Both adiabatic and heat flow calorimeters, presently used for inpile applications in Hungary, are described. 7 references. (J.M.J.)

49983 (ORNL-TM-1559(Rev.1)) AN INTERVAL TIMER DESIGNED FOR USE DURING IRRADIATIONS AT THE HEALTH PHYSICS RESEARCH REACTOR. Thorngate, J. H.; Littleton, C. P. (Oak Ridge National Lab., Tenn.). Jun 1972. Contract W-7405-eng-26. 22p. Dep. NTIS.

An improved version was made of the timer originally described in ORNL-TM-1559. The timer will terminate reactor runs up to 27.7 hours in length in one-second increments and $^{1}/_{60}$ second accuracy. Premature reactor shutdowns will stop the timer as will any manual shutdown. Timer control of a reactor run can be disabled to manually terminate runs. The method of interfacing with the reactor was not changed, but the instrument was modernized by using integrated circuits. In addition, a five-digit mechanical register was obtained to perform the basic timing function with a resultant simplification in the associated electronic circuits. Modular packaging similar to that used for other reactor control units was adopted to facilitate servicing. (auth)

49984 (ORNL-TM-3715) SUBCRITICALITY MEASUREMENTS IN FTR-3: THE HOMOGENEOUS MOCKUP OF THE FAST TEST REACTOR. Kryter, R. C.; Ackermann, N. J. Jr.; Buhl, A. R. (Oak Ridge National Lab., Tenn.). 29 Feb 1972. Contract W-7405-eng-26. 119p. Dep. NTIS.

A series of experiments was performed in the ZPR-9 critical assembly at the Argonne National Laboratory to investigate the capability of various measurement techniques in determining the subcriticality of a large, fast-spectrum reactor. Both static and dynamic techniques were studied, subject to the realistic constraints of employing neutron detectors capable of withstanding high temperature and gamma flux and positioned in the reactor's radial reflector region. The full-range subcriticality measurement method proposed by ORNL (namely, the modified neutron source multiplication technique, calibrated near delayed critical by the breakfrequency neutron noise analysis technique and refined through numerical calculations of possible neutron detection efficiency alterations) proved both accurate and workable. (auth)

49985 (ORNL-TM-3800) FAST REACTOR SHIELDING. Activity No. 40 01 61, 189a No. 10028. Monthly Progress Report, March 1972. Mynatt, F. R.; Gritzner, M. L.; Maerker, R. E.; McGregor, B. J. (Oak Ridge National Lab., Tenn.). 15 May 1972. Contract W-7405-eng-26. 56p. Dep. NTIS.

Data and interim results are presented for the following shielding studies: FFTF, Pipe Chase Experiment, Sodium Benchmark Experiment, and Stainless-Steel Benchmark Experiment. (J.M.J.)

49986 (RT/ING-(72)6) COURSE IN EXPERIMENTAL NUCLEAR ENGINEERING FOR STUDENTS AND GRADUATES. I. REACTORS. Bozzi, L.; Di Palo, L.; Lo Prato, E.; Martinelli, R.; Martini, M.; Moccaldi, A.; Orestano, F. V.; Pistella, F.; Santandrea, E. (Comitato Nazionale per l'Energia Nucleare, Rome (Italy)). 14 Mar 1972. 242p. (In Italian). Dep. NTIS (U. S. Sales Only).

Introductory lessons for experiments of Nuclear Engineering are reported. The experiments were performed at the C.S.N. Casaccia in the frame of a training course for graduate students on September 1971. Experiments on reactor facilities are described. (auth)

49987 (SRRC–43/71) ANNUAL REPORT, 1970–1971. Wilson, H. W. (Scottish Research Reactor Centre, East Kilbride (Scotland)). 1971. 23p. Dep. NTIS (U. S. Sales Only).

Nuclear research projects investigated at the Scottish Research Reactor Center during 1970 and 1971 are reviewed. Operations for the Scottish Universities Reactor during 1970 and 1971 are described. (D.C.C.)

49988 (UJV–2649–R) SHIELDING CALCULATIONS FOR THE ZRR REACTOR. Stoces, B.; Burian, I.; Rataj, J. (Ceskoslovenska Akademie Ved, Rez. Ustav Jaderneho Vyzkumu). Sep 1971. 36p. (In Czech). Dep. NTIS (U. S. Sales Only).

The shielding calculations for the Czechoslovak fast reactor were carried out on the basis of a cooperative arrangement with Soviet scientists at the Obninsk Physico-Energetic Institute. Preliminary experiments with the BOR-60 reactor selected specific shielding materials for further study. A new computer program was developed and adapted for conditions prevailing in fast reactors. Introduction of loops in the design of the reactor under construction at the Skoda Works modified the original configuration and required considerable changes in the shield. The spatial and energy distribution of neutrons was determined both by the neutron diffusion method and by Carlson's S_n method, based on the solution of the neutron transport and γ radiation equations. The results yielded information applicable to the design of the upper, lower, and lower core shields and to the primary circuit and the heat exchanger. 10 references. (TTT)

49989 REACTIVITY INVESTIGATIONS AT THE ARGONAUT REACTOR. Mueller, Hj. (Institut fuer Theoretische Physik und Reaktorphysik, Graz). Acta Phys. Austr.; 34: No. 1-2, 22-34(1971). (In German).

Described is a method through which the excess reactivity of the Argonaut reactor can be varied in small steps of 0.04. Total core configuration as well as total amount of fuel remain unchanged. This method is explained on hand of both experimental and theoretical results. (tr-auth)

Production Reactors

49990 (CONF-720607–15) COMPUTER SURVEILLANCE OF REACTIVITY DURING STARTUP AT HFIR. Sides, W. H. Jr.; Allen, J. W.; Bullock, J. B. (Oak Ridge National Lab., Tenn.). 28 Jan 1972. 4p. Dep. NTIS.

From 18th annual American Nuclear Society conference; Las Vegas, NV. (18 Jun 1972).

49991 (DP–1298) CONFINEMENT OF AIRBORNE RADIOACTIVITY. Progress Report, July–December 1971. Evans, A. G.; Jones, L. R. (Du Pont de Nemours (E. I.) and Co., Aiken, S. C. Savannah River Lab.). May 1972. Contract AT(07-2)-1. 21p. Dep. NTIS.

Screening tests on 21 different iodine adsorbers were continued to aid in selecting a replacement carbon for the Savannah River Plant confinement system. Carbon samples impregnated with I_2, KI_3, triethylenediamine (TEDA), KI, PbI_2, and Ag were subjected to high-intensity gamma irradiation, high-temperature desorption, and simulated service aging tests. Coconut-base carbons impregnated with either TEDA or TEDA plus KI were found to have the best overall iodine retention properties under the test conditions. Two new test facilities for carbon weathering and high-intensity gamma irradiation were designed and partially constructed. Iodine adsorbers selected from the screening tests will be evaluated in the new test facilities. (9 references) (auth)

49992 (DUN-SA–175) OPERATION OF HIGH WORKING PRESSURE DIFFERENTIAL PRESSURE TRANSDUCER. Worster, L. D. (Douglas United Nuclear, Inc., Richland, Wash.). [nd]. 5p. Dep. NTIS.

The differential pressure transducer operation, maintenance and calibration techniques discussed were developed during the six years operation of the 1003 channel coolant flow monitor at the N Reactor. The 1003 differential pressure transducers in the system include three ranges: 0 to 20, 0 to 28 and 0 to 35 psid. The system working pressure is 1600 psig. (auth)

Reactor Components, Fuels, and Accessories

Refer also to abstracts 48117, 48321, 48326, 48327, 48338, 48374, 48385, 48405, and 49680.

49993 (HEDL-TME–72-79) ACCOMMODATION OF UNCERTAINTIES IN SHIELD DESIGN. Marr, D. R.; Figg, J. A. (Hanford Engineering Development Lab., Richland, Wash.). May 1972. Contract AT(45-1)-2170. 19p. Dep. NTIS.

A method for determining the dose uncertainty in a point kernel calculation which results from uncertainty in the shield parameters is shown. The nonsymmetric confidence limits are determined for the desired degree of confidence. The resulting shield design is more compact than that obtained by the common use of parameter bounding values in accommodating the uncertainty. (auth)

49994 (ORNL-TM–3782) SELECTION AND PROCUREMENT OF PRESSURE RELIEF VALVES FOR LIGHT-WATER-COOLED NUCLEAR REACTOR SYSTEMS. (Oak Ridge National Lab., Tenn. MPR Associates, Inc., Washington, D. C. (USA)). Jun 1972. Contract W-7405-eng-26. 99p. Dep. NTIS.

Protection against overpressure must be provided in nuclear reactor systems. Overpressure causal conditions and controls and special requirements for pressure relief valves used in pressurized-water and boiling-water reactor systems are discussed to provide background information. The pressure relief systems currently used in both pressurized- and boiling-water reactor plants as well as those considered for future plants are discussed. The three basic types of pressure relief valves used for overpressure protection in nuclear power plants are described; guidelines for their selection with respect to design, performance, and materials are presented; and their recommended maintenance and testing procedures are discussed. (auth)

49995 (ORNL-TM–3858) PRESSURE VESSEL RELIABILITY AS A FUNCTION OF ALLOWABLE STRESS. Arnold, H. G. (Oak Ridge National Lab., Tenn.). Jun 1972. Contract W-7405-eng-26. 91p. Dep. NTIS.

Thesis. Submitted to Univ. of Tennessee, Knoxville.

The reliability of nuclear pressure vessels was investigated by probabilistic design methods to develop analytical expressions for evaluating the adequacy of existing allowable stress intensities. The change in reliability resulting from changes in allowable stress intensities was also investigated. Analytical expressions were derived and combined with existing methods of reliability analysis and stress analysis to calculate failure probability as a function of general membrane stress, burst pressure, and cyclic stress amplitude. The results were applied to typical distributions of induced stress and material strength to demonstrate the method by which pressure vessel reliability can be estimated. It was found that existing allowable stress intensities result in very high estimates of reliability when bursting or yielding under a steady-state pressure is defined as failure. However, when fatigue failure is considered, the probability of failure resulting from allowable cyclic stress amplitudes was found to be significantly higher. It was therefore concluded that consideration should be given to lowering the allowable cyclic stress amplitudes. It was also concluded that the allowable membrane stress intensities can be substantially increased without producing a significant change in the estimated failure probability. 16 references. (auth)

49996 (RD/B/N–2274) BURNABLE POISONS: AN EXPERIMENTAL DEPLETION AND COMPARISON WITH THEORETICAL PREDICTION. Beynon, A. J.; Gavan, T. (Central Electricity Generating Board, Berkeley (England). Berkeley Nuclear Labs.). Mar 1972. 40p. Dep. NTIS (U. S. Sales Only).

The accuracy of theoretical methods of predicting the self-shielded depletion of a cylinder of a gadolinium-based burnable poison was determined by irradiating a column of discs of magnesia-diluted gadolinia in the reflector of DIDO. The flux varied along the column by a factor of 10 and depletions on discharge varied from 90% at the bottom to 10% at the top. Neutron exposure as a function of time was determined by regular flux measurements along the column, and after irradiation radiographs were taken. Discs were then selected for isotopic analysis and theoretical methods were used to determine the residue of poison expected in each. Values of poison residue determined by a theoretical treatment in which the flux was isotropic and azimuthally symmetric showed a peak deviation from measured values of 1.0 ± 1.4% of the initial value. In a treatment where the point incident vector flux was of the form $\cos\theta \, d\Omega$, where θ was the angle between the direction of $d\theta$ and the horizontal the depletion was overestimated and deviations ranged up to 4.5 ± 1.7% of the initial value with a tendency to increase with depletion. (UK)

49997 (RDT-E-4-20-T(5-72)) HEAT EXCHANGER FOR GAS COOLER. (Division of Reactor Development and Technology (AEC), Washington, D. C.). May 1972. 34p. RSO.

The standard delineates the requirements for the design, fabrication, and quality assurance for heat exchangers that cool inert gas or air. The standard applies to stationary heat exchangers to be used for cooling circulating inert gas or air which has been heated by hot reactor plant components or reactor fuel decay. (auth)

49998 PERFORMANCE MODELING OF NEUTRON ABSORBERS. Homan, F. J. (Oak Ridge National Lab., Tenn.). Nucl. Technol.; 16: No. 1, 216-25(Oct 1972).

A computer code to predict the performance of fast reactor control rods was developed and used to analyze the integrated behavior of a typical FTR-type control rod in Row 2 of EBR-II. In particular, the influence of the ^{10}B enrichment and solid reaction product swelling were considered. It is noted that control rod claddings are predicted to begin rapid plastic strain very shortly after the fabricated gap between the absorber pellets and the cladding has closed, due to high contact pressure which develops with continued pellet swelling. Models for helium gas bubble swelling and release are presented, which suggest minimum swelling from this source at about 1000°C. (25 references) (auth)

49999 BORON CONCENTRATION GRADIENT FOR IMPROVED THERMAL REACTOR PERFORMANCE OF BORON-STAINLESS-STEEL CONTROL RODS. Beaver, R. J.; Richt, A. E. (Oak Ridge National Lab., Tenn.). Nucl. Technol.; 16: No. 1, 187-96(Oct 1972).

The performance of conventional 2 to 3 wt % ^{10}B-stainless steel alloys and powder dispersions is limited in thermal reactors because the ^{10}B(n,α) reactions are localized at and near the surface of the material. Significant swelling occurs after a relatively short exposure, and additional exposure creates drastic damage to the microstructure in the localized regions. By designing a symmetrical boron concentration gradient in which the ^{10}B is limited at the surface and increases in a prescribed manner to higher concentrations below the surface, the performance capability of boron-stainless steel neutron absorbers can be increased substantially. This concept was exploited in the 10 MW SM-1 Reactor. The Neutron Absorber Section Assembly of the Control Rod is a rectangular parallelepiped consisting of four 0.090-in.-thick plates clad with 0.032-in.-thick austenitic stainless steel. The ^{10}B concentration at the surface of the plate was established as 1 wt % ^{19}B, and in a programmed manner increased to 3 wt % ^{10}B 0.024 in. below the surface. For an intended fluence of 4.3×10^{20} nvt (thermal) this technique limits the ^{10}B consumption in any volume increment to 36×10^{20} atoms/cm^3 (maximum). Thus, the allowable average ^{10}B burnup for the onset of swelling can be increased from 5 at. % burnup, the limit for conventional dispersions, to 20 at. % burnup. This improvement was demonstrated by the post-irradiation examination of a boron-gradient neutron absorber which contained ^{10}B dispersed in Type 200 austenitic stainless steel, and operated for six years in the central region of the active lattice of the SM-1 Reactor. (7 references) (auth)

Reactor Physics and Core Engineering

Physics

Refer also to abstract 49310.

50000 (AAEC/E-228) TWO-REGION CRITICAL EXPERIMENTS ON BeO-^{235}U REACTORS. Marks, A. P. (Australian Atomic Energy Commission Research Establishment, Lucas Heights). Jan 1972. 75p. Dep. NTIS (U. S. Sales Only).

Reactor physics properties of a series of BeO-^{235}U assemblies were measured as part of a program of development of a high temperature gas cooled reactor. Five such assemblies with moderator to fuel ratios ranging between 737 and 6539 to unity were placed between the core tanks of the Argonaut type reactor MOATA. Each assembly occupied a volume of one cubic foot and was subcritical in isolation; inserted into MOATA the assemblies formed a two-region critical system. Complete details of mechanical arrangements for the assembly components and for methods of emplacement in the reactor are given. The limitations inherent in the availability of materials and the restricted volume for assembly location are discussed. Details are given of methods used for approach-to-critical and for calibration of control absorbers on each assembly. Both theory and practical aspects of measurements made are covered. Reference is made to differential neutron spectra by time-of-flight and chopper techniques, epithermal neutron spectra by activation of integral detectors, fission rate ratios by use of gas flow chambers, and reactivity measurements by long period sample oscillation. The methods employed are critically examined, and difficulties and disadvantages stated; in some cases alternative methods are compared. An account is given of theoretical calculations complementing the measured values. The limited volume available prevented asymptotic spectra being attained, and the geometrical complexity led to serious difficulties in setting up the calculational model. The possibility of using discrepancies between experiment and calculation as a means of improving basic nuclear data and calculational methods was impaired by the compromises necessitated by the modelling difficulties. Nevertheless it is shown that experimental values could be reconciled with those calculated with the aid of some empirical adjustment, thus demonstrating internal consistency. The work served to highlight the known need for simple geometry for the study of such assemblies, and provided valuable experience in evaluation of experimental and data analysis techniques. (auth)

50001 (AEEW-R-778) TWO DIMENSIONAL TRANSPORT CODE TWOTRAN. A USERS GUIDE TO THE WINFRITH FORTRAN IV VERSION FOR USE ON THE IBM 360 COMPUTER. Harris, D. (Atomic Energy Establishment, Winfrith (England)). Oct 1971. 67p. Dep. NTIS (U. S. Sales Only).

The modified version of the two dimensional neutron transport code TWOTRAN for use on the IBM 360/75 is presented. The WIMS "E" Version is described; an edit routine to derive effective control rod data for use in diffusion codes is also detailed. Specimen input and output is presented together with recommendations for running the code. 14 references. (auth)

50002 (AERE-R-6862(Rev.)) ABSOLUTE YIELDS IN THE FISSION OF ^{235}U, ^{238}U, AND ^{239}Pu IRRADIATED IN DFR. Cuninghame, J. G.; Goodall, J. A. B.; Willis, H. H. (Atomic Energy Research Establishment, Harwell (England)). May 1972. 17p. Dep. NTIS (U. S. Sales Only). UK 50 pence.

Absolute fission yields were measured for 14 nuclides in the fission of ^{235}U and ^{239}Pu in pitch 30 of D.F.R. and for 10 nuclides in fission of ^{238}U in pitch 36. The value found for ^{99}Mo in ^{235}U fast fission of (5.43 ± 0.22)% is 10% lower than the one in current use and must now be regarded as being the correct value for the particular neutron spectrum used. The measurements once again emphasized the truth of the assertion that if accurate fission yields are needed for any purpose, they must probably be measured in a neutron spectrum closely approximating to the one for which they are required. (auth)

50003 (ANL-7719) ARC SYSTEM ONE-DIMENSIONAL ADJUNCT CALCULATIONS AND EDITS. Neal, D. E.; Daly, T. A.; Schoengold, D. A.; Main, G. Jensen; Kovalsky, E. A.; Leaf, G. K. (Argonne National Lab., Ill.). Mar 1972. Contract W-31-109-eng-38. 522p. Dep. NTIS.

A description of the ARC System modules AJC003, AJC001 and NUE001, which perform one-dimensional adjunct computations in terms of flux, geometry, boundary, and cross-section data provided, is presented. The module AJC003 provides first-order diffusion-perturbation theory estimates of $\delta k/k^2$ for changes in cross-section data, in composition-region assignments, and in the reactor half-height. On user option delayed neutron fractions, β-eff, and a reactivity table may also be computed. The module AJC001 produces a neutron inventory of the various source and reaction rates for all isotopes and specified materials and compositions. Leakage rates, breeding and conversion ratios, and reaction rates for specified foils may also be obtained. The module NUE001 provides an output edit consisting of flux and power integrals and averages, fission densities, fission sources, currents, neutron sources and removals, and leakages. Various user options may be specified. (auth)

50004 (CISE-R-174) DIGITAL METHOD FOR THE CALCULATION OF THE TRANSFER FUNCTION. Barbieri, G.; Brusa, L.; Ghirardi, A.; Giorcelli, M.; Muscettola, M. (Centro Informazioni Studi Esperienze, Milan (Italy)). Jul 1967. 40p. (In Italian). Dep. NTIS (U. S. Sales Only).

A mathematical formulation is derived for the numerical computation of transfer functions of multivariable linear systems. A digital code for IBM 7040 employing this method is described and examples presented. (auth)

50005 (CISE-R-263) HETEROGENEOUS INTERPRETATION OF EXPERIMENTS WITH FEW FUEL ELEMENTS. Pedretti, F. (Centro Informazioni Studi Esperienze, Milan (Italy)). Feb 1968. 23p. (In Italian). Dep. NTIS (U. S. Sales Only).

A possible approach to interpret coherently experiments with few fuel elements by means of heterogeneous methods is described. The theory of S. Corno is generalized to the case of several fuel elements in order to determine the heterogeneous parameters of the channel as functions not only of the material composition, but also of the incoming spectrum once the element is placed in a predetermined lattice. This result permits an iterative procedure in a spatial heterogeneous code to be utilized. Such a procedure gives the true values of the heterogeneous parameters and from them the exact behavior of the neutron distribution in a reactor. The age model is used in slowing-down; the only channel parameters which have been considered are γ_M and η_M. However, the theory can be written in the multigroup approach, with a finer description of the channels. (auth)

50006 (CISE-R-274) PARETE: THEORETICAL MODEL FOR THE CALCULATION OF HETEROGENEOUS PARAMETERS OF ABSORBENT AND MULTIPLYING CANALS. **Bruschi, C.; Pedretti, F. (Centro Informazioni Studi Esperienze, Milan (Italy)). Feb 1969. 147p. (In Italian). Dep. NTIS (U. S. Sales Only).**

The use of heterogeneous methods requires the definition and calculation of the absorption and emissivity characteristics, i.e., γ and η', of the heterogeneous elements (fuel elements, control rods, etc.). These characteristics can be deduced in a very simple manner, conceptually, from information obtained from a few group cell calculation. In this way one has the advantage of having homogeneous and heterogeneous calculations derived from the same theory. In such a way the results will tend to coincide whenever the cell approximation with a very large periodic structure and with only one heterogeneous element is considered. 8 references. (auth)

50007 (FEI-275) NUMERICAL INTEGRATION OF NON-STATIONARY MANY-GROUP DIFFUSION EQUATIONS FOR THE TRANSFER OF NEUTRONS IN A ONE-DIMENSIONAL REACTOR. **Kolosov, B. I. (Gosudarstvennyi Komitet po Ispol'zovaniyu Atomnoi Energii SSSR, Obninsk. Fiziko-Energeticheskii Institut). 1971. 36p. (In Russian). Dep. NTIS (U. S. Sales Only).**

One of the numerical solution methods is given for the non-steady-state equations of a reactor in experiments with a pulsed neutron source. Besides a general formulation of the numerical algorithm, attention is given to the theoretical investigation of the stability of the proposed method, the effectiveness of which is illustrated by a sample calculation. An Algol program "NEPTUN" is included, being an expanded variation of the previously published program "SPEKTR". 17 references. (tr-auth)

50008 (IFA-FR-88) NEUTRON FLUX SYNTHESIS METHOD. **Anton, V.; Pavelescu, M. (Institutul de Fizica Atomica, Bucharest (Romania)). 1971. 33p. (In Rumanian). Dep. NTIS (U. S. Sales Only).**

The spatial and energy distribution of neutrons in large reactors cannot be conveniently calculated by solving the diffusion equation because of computing difficulties; the synthesis method is therefore of great practical interest. It involves finding approximate flux distribution equations from two-dimensional calculations at various axial regions, and weighting functions, to derive a one-dimensional differential system, from which the three-dimensional flux may be derived. Success in the use of the method depends on the selection of the proper approximation functions. The system may be used to determine not only the spatial but also of the time dependence of the neutron flux and to study burnup problems. The flux is considered as a linear combination of known functions, depending on one or several variables. The method may be used within the multigroup formalism. The orthogonal character of the functions was found to affect only slightly the results, which may be further improved by using discontinuous approximation functions. 42 references. (TTT)

50009 (IFA-FR-91) CALCULUS OF THE HYDROGENEOUS MULTIPLYING MEDIA. **Maianu, E. (Institutul de Fizica Atomica, Bucharest (Romania)). Feb 1972. 29p. Dep. NTIS (U. S. Sales Only).**

A method is described for calculating the critical parameters and relative reaction rates for homogeneous water moderated assemblies. The method is based on a spherical P-1 approximation to the transport equation. (auth)

50010 (LA-4938) GENERALIZED, FINITE-DIFFERENCED, DIFFUSION EQUATION FOR NEUTRON-TRANSPORT COMPUTATIONS. **Alcouffe, R. E. (Los Alamos Scientific Lab., N. Mex.). Jul 1972. Contract W-7405-eng-36. 17p. Dep. NTIS.**

A generalization of the neutron diffusion equation is derived which improves the results obtainable by conventional diffusion theory for multidimensional systems. The technique employs one-dimensional trial solutions to reduce the two-dimensional transport equation to the form of the neutron diffusion equation, thereby allowing the leakage terms to more closely approximate those appropriate for transport theory. A brief theoretical analysis shows that the accuracy of the generalized diffusion solution is linearly proportional to the difference between the trial solutions used and the exact transport solution. Four examples demonstrate the utility of the method for realistic systems for which a two-dimensional transport theory analysis is required. These results indicate that, even with an unsophisticated use of the trial solutions, the errors in integrated parameters are reduced to the order of a percent or less with the same computation time for the conventional diffusion plus that required for the trial solution generation. It is also demonstrated that an accurate one-dimensional trial solution for every region of the system leads to a generalized diffusion equation that almost reproduces the transport theory results, consistent with the conclusions of the theoretical analysis. 7 references. (auth)

50011 (ORNL-TM-3793) JOB STREAM OF CASES FOR THE COMPUTER CODE CITATION. **Vondy, D. R.; Fowler, T. B. (Oak Ridge National Lab., Tenn.). Jul 1972. Contract W-7405-eng-26. 301p. Dep. NTIS.**

A series of cases is described, input data requirements given and results reported, for the CITATION computer code which applies finite-difference diffusion theory in up to three space dimensions. These are reference problems which collectively exercise many different options programmed in this code, and therefore serve to verify proper implementation of it. Included are non-dimensional, one-, two-, and three-dimensional eigenvalue problems of various kinds, fixed source problems, and sophisticated fuel managment problems carried through several fuelings. Not only is the capability for criticality search exploited, but for several cases the adjoint eigenvalue problem is also solved and first-order perturbation results obtained and reported. 4 references. (auth)

50012 (ORNL-TM-3893) SUGGESTED METHOD FOR SOLVING THE NEUTRON DISTRIBUTION EQUATIONS FOR A CRITICAL SYSTEM WITH SOURCE TERMS. **Tobias, Melvin (Oak Ridge National Lab., Tenn.). 7 Jul 1972. 5p. Dep. NTIS.**

The problem of finding the solution vector to the matrix problem $T\vec{\phi} = \vec{s}$ is discussed in the case that the determinant of T is zero. The permissible form of $\vec{s}$ is described and a method for computing $\vec{\phi}$ is outlined. This problem originates in the application of perturbation theory to reactor burnup problems. Most of the necessary computing procedures are believed to be available already in the CITATION code. (auth)

50013 STATISTICAL ACCURACY IN NUCLEAR REACTOR NOISE ANALYSIS. **Vaurio, J. K. (Imatran Voima Osakeyhtio, Helsinki). J. Nucl. Energy; 26: No. 7, 349-66(Jul 1972).**

The statistical accuracy of the interesting parameters in nuclear noise measurements was studied theoretically. The minimum variance error estimation was applied to one- and two-detector measurements. The error analysis carried out for periodogram estimators could be applied to both spectral density measurements and covariance function measurements. A comparison between the cross- and autospectral density measurements was made, and previous results were adjusted and extended. The error was also estimated for the Rossi-α and related measurements. These results can be applied in other branches of nuclear physics, e.g., in half-life measurements when there is significant background radiation present. The interpretation is primarily given in terms of a zero-power point reactor model. The results of the present analysis may be utilized in comparing various methods and in planning and optimizing an experiment. (auth)

50014 MULTIPOINT P_3 METHOD FOR SOLVING A NEUTRON TRANSPORT EQUATION. **Matausek, M. V. Rad. Zavoda Fiz.; 9: 29-39(1971).**

The method of discrete energy representation of thermal neutron spectra is improved by suggesting a simpler and more straightforward numerical procedure for transforming a space—angle—energy-dependent neutron transport equation into a coupled system of space—angle equations at the given energy points. By using the Lagrange-type interpolation scheme, a formula is derived for the coupling coefficients, i.e. the scattering matrix construction. The applicability of the energy point method is further extended, by combining it with the spherical harmonics method, for calculating also the space distribution of neutron flux in a multizone reactor lattice cell. The proposed method is suitable for treating plutonium-containing systems, since the energy points can be distributed to provide efficient plutonium reaction rate calculation, while the spherical harmonics method takes into account thermal neutron flux anisotropy, especially pronounced in the presence of plutonium. (1 figure, 1 table) (auth)

Core Thermal Hydraulics

50015 (EUR-4815) EXPERIMENTAL THEORETICAL STUDY OF VIBRATIONS INDUCED BY PRESSURE FLUCTUATIONS IN CYLINDRICAL NUCLEAR FUEL ELEMENTS IMMERSED IN AN AXIAL LIQUID COOLANT. Russo, S. (European Atomic Energy Community, Ispra (Italy). Joint Nuclear Research Center). May 1972. 68p. (In Italian). Dep. NTIS (U. S. Sales Only). EUR BF 85,-.

An analytical model is described characterizing the correlation between parallel-flow induced vibrations of cylindrical elements (making up a nuclear reactor core) and the random pressure fluctuations. Results of measurements carried out in a test scheme with annular water flow simulating the reactor cooling circuit are presented. There is good agreement between the theoretical predictions and experimental results. (auth)

50016 (RD/B/N-2322) HETEMP: A HETEROGENEOUS TEMPERATURE PROGRAM. Howarth, N. (Central Electricity Generating Board, Berkeley (England). Berkeley Nuclear Labs.). May 1972. 23p. Dep. NTIS (U. S. Sales Only).

HETEMP is a program to solve the two dimensional heat conduction equations in a block of moderator containing an arbitrary array of circular channels. The moderator is restricted to having constant thermal conductivity and a uniform heat source within it. The outer boundary is circular and may have a leakage condition imposed on it. Channels treated are of two types, source channels with a specified heat source and sink channels with a boundary condition depending on the coolant temperature. The contents of both types are assumed to be azimuthally symmetric. The program calculates the first two Fourier components of temperature (constant and cos θ variation) on the channel wall. Assuming diffusion theory in a series of azimuthally symmetric annuli, the temperatue distribution within a source channel is also calculated. A point temperature may be obtained anywhere in the moderator. HETEMP is written in FORTRAN IV for the IBM 1130 computer: running times are up to half a minute for typical cases. Problems are limited, by storage requirements, to a maximum of 40 source channels and 30 sink channels. Thus the program will be most useful for dealing with small regions of a reactor core. Any consistent set of units may be used. (auth)

GENERAL

Civilian Defense

50017 (AERE-R-6746) EVALUATION OF AN S.D.I. SYSTEM BASED ON "NUCLEAR SCIENCE ABSTRACTS" AND THE PERFORMANCE OF MATCHING BY WORDS IN TITLES COMPARED WITH INDEXING TERMS. Olive, G.; Datta, S.; Terry, J. E. (Atomic Energy Research Establishment, Harwell (England)). Mar 1971. 22p. Dep. NTIS (U. S. Sales Only).

A Selective Dissemination of Information service based on computer scanning of Nuclear Science Abstracts tapes has operated at Harwell since October, 1968. Users' interest profiles are constructed using Euratom indexing terms and NSA subject categories and matched against the Euratom indexing terms and subject categories assigned to each item in NSA. The performance of the mechanized SDI service has been compared with that of the pre-existing current awareness service which is based on visual scanning of journals and reports by information staff. The visual service was found to be providing an important service of good currency and high precision, about 90%, to a limited number of users. The mechanized service is less selective and of lower precision, approximately 50%, but can be expanded more readily. (W.H.K.)

Law

Refer also to abstracts 48150, 48524, 49314, and 49473.

50018 (AEC-tr-7318) RADIOLOGICAL PROTECTION LEGISLATION, OCTOBER 1971. Translation of French report. 22p. Dep. NTIS.

Legislation and recommendations relevant to radiation protection in countries comprising the European Atomic Energy Community (EURATOM) during 1971 are summarized. The recommendations are based on those of the International Commission of Radiological Protection (ICRP). The basic radiation protection standards are not directly applicable to every member country, since it has been left to each country to institute adequate legal and administrative regulations to ensure protection of the public against any hazards from ionizing radiations. Examination of the basic standards and their revisions during the 12 years since they were implemented led to the conclusion that the standards are adequate for the expanded operation of industrial installations using radioactive materials. (C.H.)

50019 (DUN-SA-173) BUDGETING, MEASUREMENT, AND ANALYSIS PROGRAM FOR EMPLOYEE RADIATION EXPOSURE CONTROL. Crass, L. L. (Douglas United Nuclear, Inc., Richland, Wash.). 31 Mar 1971. 4p. Dep. NTIS.

A computerized data recording system was developed for use in the control of the radiation dose received by reactor personnel. All radiation zone work is planned to keep employee exposure within basic limits (300 mrem per single exposure or during seven consecutive days; 2.5 rems per quarter; and 3 rems per year). This is accomplished by establishing exposure needs at the beginning of the calendar year and an exposure use-rate budget being established for each reactor by work group classification based on planned refueling and maintenance outages, plus a ten percent margin added for unplanned work. The whole-body dose of each employee is measured by an assigned β-γ dosimeter, which he is required to wear when entering the radiation zone. These dosimeters are exchanged and processed monthly. Each employee also wears a γ pocket dosimeter each time he enters a radiation zone. Radiation technicians record the data on the pocket dosimeters and send them to the computer center. The exposure control report on each individual is revised and sent to component management daily. Each month this report is updated on the basis of the reading of the β-γ dosimeter. This provides a continuous running exposure accounting record for each employee that is used by component managers for budgeting daily exposure assignments. The data are reviewed monthly and used as a basis for changes in scheduled work to assure that no employee receives an exposure in excess of any AEC limit. (C.H.)

50020 (INIS-mf-184) ANNUAL REPORT FROM SEPTEMBER 1, 1969-AUGUST 31, 1970. (Comision Nacional de Energia Nuclear, Mexico City). 1970. 76p. (In Spanish). INIS.

The annual report of the activities including the organization, administration, financing and progress reports of the different divisions is presented. (INIS)

50021 (KFK-1565) DIVISION OF RADIATION PROTECTION AND SAFETY ANNUAL REPORT, 1971. Kiefer, H.; Koelzer, W. (eds.). (Kernforschungszentrum, Karlsruhe (West Germany)). Mar 1972. 217p. (In German). Dep. NTIS (U. S. Sales Only).

Performing and safeguarding radiation protection and technical safety in the conventional and nuclear fields at the Karlsruhe Nuclear Research Center are duties of the Radiation Protection and Safety Department. This report informs about the different duties, lists the results of routine measurements of 1971, and covers recent results of investigations and developments in the Working Groups of the Department. (auth)

50022 (PRNC-144) ANNUAL REPORT 1970. (Puerto Rico Nuclear Center, [Mayaguez]). Contract AT(40-1)-1833. 157p. Dep. NTIS.

Brief summaries are given of research in the areas of neutron diffraction, radiation and hot-atom chemistry, cold neutron spectroscopy, radiation damage, nuclear engineering, clinical radioisotope applications, radiotherapy, tropical agro-sciences, induced sterility in insects, medical sciences and radiobiology, reactor operations, health and safety, and radioecology. Information and education services are outlined and publications issued, papers presented, and seminars held are listed. (C.E.S.)

50023 (RCN-169) SIMPLE METHOD FOR THE CONSTRUCTION OF SPLINES WITH PIECEWISE PRE-DESCRIBED SURFACES OVER GIVEN INTERVALS. van der Vorst, H. A. (Reactor Centrum Nederland, Petten). Feb 1972. 19p. Dep. NTIS (U. S. Sales Only).

In several physical problems a histogram is delivered rather than a continuous function. Essentially we think of problems where mean values are measured over certain intervals. If the physicist wishes to reconstruct the original function from this mean-value-histogram, then a reasonable constraint on this continuous function will be that this function has the same mean values over the given intervals as the histogram has. Treating this problem we meet several difficulties. If we use polynomial splines for an approximation, it seems logical that the problem can be solved by choosing an adequately high degree of the splines. In general, however, we want a very smooth approximation rather than a wildly fluctuating one. This is a reason for choosing the degree of the splines low. But, having fixed the degree, it is uncertain whether under the given circumstances such an approximation exists. The algorithm in this report is a very simple one. An advantage of this algorithm is that we can see which intervals cause the trouble in converging to a final approximation. It allows the applicant some freedom in constructing a smooth approximation. We will mention these possibilities briefly after a detailed description of the algorithm. Anyhow, the algorithm is applied easily to higher degree splines. An ALGOL'60 text has been added to this report. (auth) (Netherlands)

Miscellaneous

50024 (ABCC-TR-3-71) LIGAND KINETICS IN HEMOGLOBIN HIROSHIMA. Nagel, Ronald L.; Gibson, Quentin H.; Hamilton, Howard B. (Atomic Bomb Casualty Commission, Hiroshima, Nagasaki (Japan)). 21 Jan 1971. 11p. Dep. NTIS.

50025 (ABCC-TR-6-71) SITUS INVERSUS TOTALIS AND KARTAGENER'S SYNDROME IN A JAPANESE POPULATION. Katsuhara, Kimiko; Kawamoto, Sadahisa; Wakabayashi, Toshiro; Belsky, Joseph L. (Atomic Bomb Casualty Commission, Hiroshima, Nagasaki (Japan)). 1972. 17p. Dep. NTIS.

50026 (ABCC-TR-24-71) PHYSICOCHEMICAL STUDIES OF THE RELATION BETWEEN STRUCTURE AND FUNCTION IN HEMOGLOBIN HIROSHIMA (HC3β, HISTIDINE → ASPARTATE). Imai, Kiyohiro; Hamilton, Howard B.; Miyaji, Takaoki; Shibata, Susumu (Atomic Bomb Casualty Commission, Hiroshima (Japan). Atomic Bomb Casualty Commission, Nagasaki (Japan)). 15 Jul 1971. 23p. (In English and Japanese). Dep. NTIS.

50027 (ABCC-TR-25-71) ADENOACANTHOMA (ADENOSQUAMOUS CARCINOMA) OF THE PANCREAS. Cihak, Robert W.; Kawashima, Taketsugu; Steer, Arthur (Atomic Bomb Casualty Commission, Hiroshima, Nagasaki (Japan)). 15 Jul 1971. 15p. Dep. NTIS.

50028 (ABCC-TR-34-71) CLINICAL ASPECTS AND SURVIVAL OF APLASTIC ANEMIA IN HIROSHIMA AND NAGASAKI, 1946-67. Ichimaru, Michito; Ishimaru, Toranosuke; Tsuchimoto, Taiso; Kirshbaum, Jack D. (Atomic Bomb Casualty Commission, Hiroshima (Japan). Atomic Bomb Casualty Commission, Nagasaki (Japan)). [nd]. 11p. (In Japanese and English). Dep. NTIS.

50029 (ARL/MET-85) SOLID-SOLUTION HARDENING IN COPPER-BASE ALLOYS. Hutchison, M. M.; Pascoe, R. T.

(Aeronautical Research Labs., Melbourne (Australia)). Sep 1971. 85p. Dep. NTIS (U. S. Sales Only).

50030 (ARL/SM–375) SOME INITIAL EXPERIMENTS WITH TIME-AVERAGED HOLOGRAPHY TO DETERMINE DYNAMICAL PROPERTIES OF VIBRATING PANELS. Joyce, N. B.; Bailey, C. M.; Struys, T. J. (Aeronautical Research Labs., Melbourne (Australia)). Mar 1972. 17p. Dep. NTIS (U. S. Sales Only).

50031 (BARC–581) DIGITAL ANALYSIS OF GAURIBIDANUR SEISMIC DATA. Manekar, A. M.; Krishnan, C. A.; Kolwankar, V. G.; Shah, B. M. (Bhabha Atomic Research Centre, Bombay (India)). 1972. 32p. Dep. NTIS (U. S. Sales Only).

50032 (BARC–586) REACTIVITY OF SUBSTITUTED ANILINE DERIVATIVES WITH HYDRATED ELECTRON. Bhattacharyya, P. K.; Saini, R. D. (Bhabha Atomic Research Centre, Bombay (India)). 1972. 11p. Dep. NTIS (U. S. Sales Only).

50033 (BARC–588) ENERGY LEVELS Tb^{3+} IN $LaBr_3$. Joshi, B. D.; Patel, B. M.; Page, A. G.; Bangia, T. R.; Saxena, R. N. (Bhabha Atomic Research Centre, Bombay (India)). 1972. 31p. Dep. NTIS (U. S. Sales Only).

50034 (BDX–613-601(Rev.)) INVESTIGATION OF INTERNAL CAVITY PRESSURE FOR INJECTION-MOLDED POLYCARBONATES. Black, P. C. (Bendix Corp., Kansas City, Mo.). Apr 1972. Contract AT(29-1)-613. 56p. Dep. NTIS.

50035 (BDX–613-153) MICROBONDING AND PACKAGING FOR HYBRID MICROELECTRONIC CIRCUITS. Final Report. Driscoll, B. J. (Bendix Corp., Kansas City, Mo.). Feb 1971. Contract AT(29-1)-613. 76p. Dep. NTIS.

50036 (BNL–16931) PERLITE–POLYMER CONCRETE. Kukacka, L. E. (Brookhaven National Lab., Upton, N. Y.). May 1972. 25p. Dep. NTIS.

50037 (BNL–16951) CORTICOSTEROID PATTERN IN RATS GENETICALLY SUSCEPTIBLE TO HYPERTENSION. Rapp, John P. (Philadelphia Zoological Society, Pa. Penrose Research Lab. Pennsylvania Univ., Philadelphia. Dept. of Pathology); Dahl, Lewis K. (Brookhaven National Lab., Upton, N. Y.). 1971. 18p. (CONF-720633–1). Dep. NTIS.

From fourth international congress of endocrinology; Washington, D. C. (19 Jun 1972).

50038 (BNL–16952) THYMUS CELL MIGRATION: ^{3}HTdR-LABELED AND THETA-POSITIVE CELLS IN PERIPHERAL LYMPHOID TISSUES OF NEWBORN MICE. Chanana, A. D.; Joel, D. D. (Brookhaven National Lab., Upton, N. Y.); Schaedeli, J.; Hess, M. W.; Cottier, H. (Bern Univ. (Switzerland). Pathologisches Institut). 1972. 7p. (CONF-720630–1). Dep. NTIS.

From fourth international conference on lymphatic tissue and germinal centers in immune reactions; Dubrovnik, Yugoslavia (26 Jun 1972).

50039 (CALT–822-44) MOESSBAUER EFFECT STUDY OF THE NATURE OF THE LATTICE ANOMALIES IN THE Fe_5Si_3–Mn_5Si_3 ALLOY SYSTEM. Chao, C. C.; Tsuei, C. C. (California Inst. of Tech., Pasadena. W. M. Keck Lab. of Engineering Materials). Aug 1972. Contract AT(04-3)-822. 43p. Dep. NTIS.

50040 (CEA-CONF–1950) STUDY OF EFFECTS OF POLLUTANTS ON THE VEGETATION IN ALPINE VALLEYS. Bossavy, Jean; Fourcy, Andre (Commissariat a l'Energie Atomique, Grenoble (France). Centre d'Etudes Nucleaires). 1971. 8p. (In French). (CONF-711133–2). Dep. NTIS (U. S. Sales Only).

From Conference on anti-pollution techniques; Grenoble, France (6 Nov 1971).

50041 (CEA-CONF–1983) PRINCIPLES OF ANALOG AND HYBRID CALCULATION. Bory, M. (Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires). 25 Feb 1972. 14p. (In French). (CONF-720214–1). Dep. NTIS (U. S. Sales Only).

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Thesis.

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This study has failed to demonstrate any direct effect of microwave radiation on the thyroid-pituitary axis of the rat. No effects were noted which were not accountable by either heating or stress. Although it is unlikely that low-level microwave radiation (less than 10 mW/cm^2) represents any appreciable hazard to man, it is suggested that further studies of the neuroendocrine responses of higher animals be undertaken. Such an investigation would not only be more extrapolatable to man but would also provide a greater understanding of the adaptive mechanisms of the organism to microwave irradiation. (auth)

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For the past thirty years there have been an increasing number of reports in the world literature concerning the biological effects of microwave irradiation on man. These effects include: neurasthenic responses to apparent low exposure levels and suspected behavioral changes (as reported in Soviet literature); neuroendocrine effects; cataractogenesis (developed in literature from the United States); cardiovascular changes; and other effects. Reports on the human subject are comparatively few considering the import and increasing uses of microwave energies in the military, commercial enterprises, industry, and the general population. Data presented regarding human biomedical effects are usually conflicting, statistical methods employed are often dubious or non-existent, and relation to control populations are most often not evident. The need for a unified continuing compilation of occupational health data, as well as the need for appropriately defined and conducted retrospective and prospective epidemiological studies is recognized and discussed. Further, the need for identifying and clinical monitoring of higher at risk exposure groups with suggested modes of accomplishing this is presented. Careful attention to dosimetry, exposure times, environmental considerations, field proximity, waveform, types and power outputs of microwave sources must be given and related to effects observed, if any, and hazard potential evaluated in the light of this information before it is to be of value in resolving the problems and confusion that exist. (auth)

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SUBJECT INDEX

Cross references are included in cumulative subject indexes and in *Subject Headings Used by the USAEC Technical Information Center* (USAEC report TID-5001).

The reader is also referred to *Guide to Abstracting and Indexing for Nuclear Science Abstracts* (USAEC report TID-4576).

Most headings in the subject index are the names of specific materials, things, and processes. Each heading is followed by a modifier that describes the properties of, or processes applied to, that heading.

All index entries cite *NSA* volume and abstract numbers; volume number precedes the colon and the abstract number follows it. The designation (R) following the abstract number indicates a progress report; (P) indicates a patent; and (T) indicates a translation. Abstracts for reports other than progress reports carry no letter designation. Report numbers, where applicable, are included in parentheses after the abstract number of the citation. Published literature (journal article or book) can be identified by the absence of a report number.

Ideas presented in the original literature, rather than key words, have been indexed. The indexers have selected what seemed the most probable and logical place to look for typical information. Since it is not always possible to anticipate where a user would look for information, the cumulative indexes include numerous cross references. Consideration of synonymous or closely related terms will prove valuable.

Information is indexed for the greatest use to the greatest number of users. This requires that a topic be indexed to headings that most specifically describe it and not ordinarily to the headings that describe its ultimate use or to the general class headings that include the specific headings. For example, information on boiler design for the Fermi Fast Breeder Reactor would be indexed under the headings BOILERS and FERMI FAST BREEDER REACTOR but not necessarily under the headings REACTORS, FAST or REACTORS, BREEDER.

General or broad headings are reserved for general summaries, reviews, comprehensive reports, and similar literature.

Subject Heading Styles

Generally, the direct form of subject entry is used rather than inverted headings; e.g., AMINO ACIDS rather than ACIDS, AMINO; HELIUM ISOTOPES He-4 rather than HELIUM—ISOTOPES He-4 or HELIUM—He-4 ISOTOPES. Note, however, that in some cases parenthetic modifying terms or inverted headings such as NEUTRONS, FAST, are used where the alphabetical arrangement of a direct entry would cause information to be scattered. In addition, organic compounds are usually entered in the index in the inverted form to facilitate grouping like or related compounds with the parent compounds; e.g., BENZENE, BROMO- rather than BROMOBENZENE.

Alphabetization

Subject headings are alphabetized word by word. Parenthetic qualifiers, numbers, and Greek letters within subject headings are disregarded in alphabetizing unless there are two or more headings that are otherwise identical, in which case the qualifier, numerical progression, or spelled names for the Greek letters determine the order.

Examples:

M-Capture
  see ELECTRON CAPTURE
MAGNESIUM
MAGNESIUM ALLOYS AND SYSTEMS
MESONS
MESONS (π)
MESONS (rho)
1-PENTANOL
2-PENTANOL
URANIUM OXIDES
URANIUM OXIDES UO_2

Modifying Phrases

The modifiers appearing under a subject heading are written specifically to show the relation between the item being indexed and the heading. The modifier therefore contains a maximum of useful information. Although the modifier begins with the word judged to be of greatest use to the greatest number of users, there is still need for the searcher to consider all modifiers under the heading(s) of interest.

Modifiers usually form meaningful phrases when combined with the subject heading. Some are intended to be read following the subject heading, e.g., the entry HYDROGEN—*sorption by charcoal,* should be read *hydrogen sorption by charcoal.* As a result of placing the important word first, however, many modifiers must be rearranged for smooth reading, e.g., FORMALDEHYDE—*yields in radiolysis of ethyl ether, effects of deuterium on,* should be read *effects of deuterium on formaldehyde yields in radiolysis of ethyl ether* and URANIUM—*crystal structure of, effect of cooling rate on allotropic transformations in,* should be read *effect of cooling rate on allotropic transformations in crystal structure of uranium.*

Special characters are added to modifiers in the fields of physics and reactor technology; if the modifier does not establish the experimental or theoretical character of a reference, a symbol (E), (T), or (E/T) is placed immediately after the modifying phrase and before the abstract number.

Physical States and Configurations of Materials

The specific physical state, if other than normal, or the geometric configuration of the material is included in the modifying phrase; e.g., information on liquid metals is indexed under the specific metal with "liquid" in the modifier and carbon crucibles is indexed under CARBON with "crucibles" appropriately placed in the modifier. The information on carbon crucibles is also indexed under CRUCIBLES.

Nomenclature of Inorganic Compounds

Inorganic compounds are indexed to subject headings in the direct form. Cations are listed in the order of increasing valence for polycationic salts of varying valence and in alphabetic order for polycationic salts in which all cations have the same valence; e.g., SODIUM ALUMINUM SILICATES and POTASSIUM SODIUM SULFATES. If more than one anionic species is presented in a compound, the anions are arranged alphabetically. e.g., BERYLLIUM FLUORIDE HYDROXIDES.

Nomenclature of Organic Compounds

Complex organic compounds occur in such variety as to require a systematic nomenclature. Headings for most substituted organic compounds are found in an inverted form following names of the parent compounds. Examples of two such headings are:

```
2,4-HEPTANEDIONE
2,4-HEPTANEDIONE, 1-PHENYL-
```

Headings are included for broad class names of enzymes, e.g., HYDROLASES and TRANSFERASES. Specific enzyme names are to be found in modifiers under these headings. Similarly, broad class names for hormones are included as headings, except in this case the headings are entered in the inverted form as, e.g., HORMONES, ADRENAL and HORMONES, SEX. The more specific names of hormones are to be found in the modifiers under the appropriate broad headings.

For compounds used as drugs, an effort is made to use subject headings that reflect the recommendations of the USAN (United States Adopted Names) compilation or the "New Names" columns of the *Journal of the American Medical Association.* The *Merck Index* has also been used in selecting subject headings for drugs.

Nomenclature of Life Sciences

Except for those in the phylum Tracheophyta, subject headings for plants are common names. For example, ALGAE, FUNGI, SLIME MOLDS, MOSSES, and LIVERWORTS are subject headings. The phylum name TRACHEOPHYTA and several classes and subclasses belonging to it are entered as subject headings. The specific classes entered are PSILOPSIDA, LYCOPSIDA, SPHENOPSIDA, and PTEROPSIDA. The three subclasses FILICINIDAE, GYMNOSPERMIDAE, and ANGIOSPERMIDAE which belong under Pteropsida are also subject headings. Scientific names (genus and species) and common names if known are used in the modifying phrase.

Subject headings for microorganisms are VIRUSES, RICKETTSIA, and BACTERIA. The name of the type or kind of virus or the genus and species names of the organisms should appear in the modifying phrase.

The names of animal phyla are subject headings. The arthropods are also indexed to subject headings for classes INSECTA, CRUSTACEA, ARACHNIDA, DIPLOPODA, and CHILOPODA. The invertebrate chordates are indexed to subject headings UROCHORDATA and CEPHALOCHORDATA. The vertebrates are indexed to headings for the classes AGNATHA, CHONDRICHTHYES, OSTEICHTHYES, AMPHIBIA, REPTILIA, AVES, and MAMMALIA as well as to the general heading VERTEBRATA. Common names are used as subject headings in the class Mammalia.

Subject headings are entered for various classes of commodities, and specific products are identified in the file-word position of the modifier. In the following examples, approved subject headings are capitalized and typical modifier file words are listed in lower case.

Example 1	Example 2
CEREALS	MEATS
bread	beef
flour	fish
oats	mutton
rice	pork
rye	poultry
wheat	seafood

Diseases, pathological conditions, and in vitro studies of atypical cells and tissues are indexed under subject headings for the organism affected, under the appropriate anatomical structure of physiological phenomenon affected, and under the appropriate disease heading. Subject headings for diseases (defined as any deviation from the norm) are common names such as ANEMIA, FIBROSIS, INFECTIONS, LEUKEMIA, NEOPLASMS, and RADIATION SICKNESS. Also, the general headings DISEASES and DISEASES, PLANTS are available as subject headings.

Multicomponent Alloys and Other Systems

Multicomponent alloys and systems, except those with well-known trade names, are indexed under a subject heading for each component in the form "element systems" for nonmetals or "element alloys and systems" for metals. The modifier begins with element symbols for each component arranged alphabetically. In addition, if significance is placed on the base metal of the alloy, this is indicated by adding "-base" to the element symbol.

Example: A 1.5C, 12Cr, 0.25V, 0.8Mo, bal Fe alloy is indexed as

```
CARBON SYSTEMS
  C--Cr--Fe-base--Mo--V, ...
CHROMIUM ALLOYS AND SYSTEMS
  C--Cr--Fe-base--Mo--V, ...
IRON ALLOYS AND SYSTEMS
  C--Cr--Fe-base--Mo--V, ...
MOLYBDENUM ALLOYS AND SYSTEMS
  C--Cr--Fe-base--Mo--V, ...
VANADIUM ALLOYS AND SYSTEMS
  C--Cr--Fe-base--Mo--V, ...
```

Well-known alloys, such as ZIRCALOY-2, are indexed under the trade name; cross references from each component of the alloy to the trade name appear in cumulative indexes.

Multicomponent systems in which nonmetallic elements are present in large percentage and which are commonly referred to as systems or mixtures are indexed in a manner similar to alloys.

Example: A tungsten–silicon preparation is indexed as

```
TUNGSTEN ALLOYS AND SYSTEMS
  Si--W, ...
SILICON SYSTEMS
  Si--W, ...
```

Multicompound systems and mixtures of inorganic compounds are indexed under the subject heading for each component compound; the modifiers begin with an alphabetical listing of compound formulas.

Example: A lead titanate–lead zirconate mixture is indexed as

LEAD TITANATES
$PbTiO_3$--$PbZrO_3$
LEAD ZIRCONATES
$PbTiO_3$--$PbZrO_3$

Mixtures of organic compounds are indexed under subject headings for each component of the mixture; the modifiers begin with an alphabetical listing of compound names.

Example:

ACETIC ACID
acetic acid--BF_3, ...
BORON FLUORIDES
acetic acid--BF_3, ...

Example:

BENZENE, CHLORO-
bromophenol--chlorobenzene, ...
PHENOL, BROMO-
bromophenol--chlorobenzene, ...

A mixed system of compounds and elements is indexed by a combined form of the preceding conventions; e.g., a dispersion of copper and alumina would be indexed as

ALUMINUM OXIDES
Al_2O_3--Cu, ...
COPPER ALLOYS AND SYSTEMS
Al_2O_3--Cu, ...

If modifiers for alloys and systems are included with other modifiers under the same subject heading, they are filed last.

Example:

CARBON SYSTEMS
deposition on nuclear fuel particles
molecular structure of
neutron total cross section for
sorptive properties for xenon
Young's modulus for
Al--C--Cr, superconductivity in
B--C, phase studies for
C--U--Zr, fabrication and physical properties of

Nomenclature of High Energy Physics

Information on particle-particle events is indexed under subject headings for the specific particles involved. The modifier file word *interactions* is followed by the specific interaction written in symbolic form. Particle nomenclature and symbols follow that of the Particle Data Group published in *Review of Particle Properties* (latest revision). For consistency the incident particle is always written first. The mass (in MeV) of a resonance state is included in parentheses after the symbol to avoid ambiguity. Hyperfragments are indicated in modifiers as in the following examples: Λ-He^5, Σ-H^3, $\Lambda\Lambda$-Be^{10}. The superscript on the right indicates the total number of baryons in the composite system.

Examples:

MESONS (π^-)
interactions $\pi^- + p \to \Lambda + K^+ + \pi^-$ at 6 GeV/c in hydrogen bubble chamber, $\Lambda K(1700)$ enhancement in, (E)
BARYONS, RESONANCE (Δ)
production of $\Delta^{++}(1236)$ and $\Delta^0(1236)$ from $K^- + p \to K^- + p + \pi^+ + \pi^-$ interactions at 2.63 and 2.70 GeV/c, (E)
HYPERNUCLEI
binding energy of $\Lambda\Lambda$-He^6, three-body α--Λ--Λ model for

Subject headings are also provided for specific models and theories.

Examples:

ELEMENTARY PARTICLE MODELS
quark, hadron total cross sections in, numerical analysis of
CURRENT ALGEBRA
PCAC hypothesis for A_1 and rho dominance in $\pi \to e + \nu + \gamma$ decay
REGGE POLE THEORY
predictions for polarization in $K^- + p \to$ anti $K^0 + n$, $\pi^- + p \to \pi^0 + n$, and $\pi^- + p \to$ eta $+ n$ interactions at high energies
SYMMETRY GROUPS
SU(2) x SU(4) intermediate-coupling model for nucleon and hyperon isobars

Nomenclature of Reactor Technology

Subject headings for reactors are of three types:

(1) Specific reactors, e.g., ARGONNE RESEARCH REACTOR, SAXTON POWER REACTOR

(2) Reactors having a common physics or engineering characteristic, e.g., REACTORS, FAST; REACTORS, ORGANIC-COOLED; REACTORS, PRESSURIZED-WATER

(3) Reactors having a common purpose, e.g., REACTORS, POWER; REACTORS, RESEARCH

Information on specific reactors, type (1), is indexed under the one specific subject heading. Information on classes or types of reactors, types (2) (characteristics) and (3) (purpose), is indexed under all applicable headings. For example, information on a heavy-water-moderated organic-cooled power reactor is indexed under REACTORS, HEAVY WATER-MODERATED; REACTORS, ORGANIC-COOLED; and REACTORS, POWER.

Subject headings exist for selected reactor components, e.g., REACTOR FUEL ELEMENTS. When applicable, headings for components are indexed even though they may have been included in a modifier under a type (2) or (3) heading. The materials in reactor components are indexed when the information is peculiar to the material.

Modifier file words under reactor headings are of two primary types: one type expresses reactor characteristics, e.g., reactivity; the other, components, e.g., control rod. If no subject heading appears for a reactor component, the heading REACTORS is used, and the component is used as the modifier file word.

A

- ACCELERATORS
  - beam windows for, brazing method for fabricating gas-tight, 26:48378(P)
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Conferences

Published conference proceedings as well as individual unpublished papers from conferences are included in this index. A CONF number is assigned to the conference if published proceedings are received and also if only a single paper is received. The base number used is year-month-sequence. Thus, the number CONF-650101 indicates that the conference was held in 1965, in January, and that this was the first January 1965 conference so received. This number would be assigned to complete published proceedings. If individual papers are received, the base number is extended to include a paper number, e.g., CONF-650101-1. As additional papers are received, they will be assigned consecutive numbers in the series, CONF-650101-1, CONF-650101-2, etc. This numbering system ensures that all papers received from a conference will be associated with that conference in this index.

If published proceedings are received after the receipt of individual papers, the complete proceedings will be abstracted and the abstract number will appear in this index with the base CONF number.

Abbreviations Used in Availability Column

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CFSTI	See NTIS
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DTIE	Available from the U. S. Atomic Energy Commission, USAEC Technical Information Center, P. O. Box 62, Oak Ridge, Tennessee 37830. (Conference papers are available on loan only.)
EM	Blueline prints of AEC engineering drawings are available from NTIS, U. S. Department of Commerce, Springfield, Virginia 22151. Current prices of the CAPE-packages may be obtained from this address. TID-4100, available from the USAEC Technical Information Center, P. O. Box 62, Oak Ridge, Tennessee 37830, contains information on all the CAPE-packages for sale.
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	26-48417	Baton Rouge, La.; Claitor's Publishing Division (1970). 588p. $20.00
CONF-700669-	(Physics of The Upper Atmosphere Conference, Eric, Italy, June 15-29, 1970)	
	26-48796	Bologna; Editrice Compositori (1971). 480p
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	26-48352	Rev. Int. Hautes Temp. Refract.; 9: No. 1, 7-130(Jan 1972)
CONF-701072-	(International Conference on Phosphate and Calcium Phosphate Metabolism, Paris, France, Oct. 14-16, 1970)	
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	26-48827	San Francisco Press, Inc
CONF-710551-	(Conference on Calorimetry and Differential Thermal Analysis, Mulhouse, France, May 3-4, 1971)	
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CONF-710961-	(Symposium on Heavy Ion Reactions and Many Particle Excitations, Saclay, France, Sept. 8-14, 1971)	
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3	26-49677	See ACRH-1000-329
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1	26-48148	See SC-DC-721065
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10	26-48917	See LBL-787(Rev.)
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CONF-720440-	(Annual Meeting of the Green River Valley Cattlemen's Association, Pinedale, WY., Apr. 29, 1972)	
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2	26-50063	See CCO-1599-56
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	26-49944	Mt. Prospect, Ill.; Institute of Environmental Sciences (1972). 610p
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BOILING CRISIS AND CRITICAL HEAT FLUX

L. S. Tong
Westinghouse Electric Corporation

August 1972

The ratio of the predicted critical heat flux (CHF) to the reactor heat flux is used as an index of the power capability of water reactors. Numerous boiling heat-transfer and two-phase-flow studies over the past 15 years have put emphasis on exploring the boiling-crisis mechanisms and on perfecting the CHF predictions. Unfortunately, the problem is more complicated than was thought. Thus far no overall analytical solution has been obtained, and the design equations for CHF predictions are empirical. In this review various types of boiling crisis are categorized according to four major flow patterns: pool boiling, bubbly flow, annular flow, and normal flow across a cylinder. The physical mechanisms of these boiling crises are described. Experimental observations are summarized and used for verifying various analyses. The missing links in the analyses are identified, and future work is recommended.

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